

MOSS FLORA

OF

NORTH AMERICA

North of Mexico

BY

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ERPODIACEAE

BY

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SPLACHNACEAE

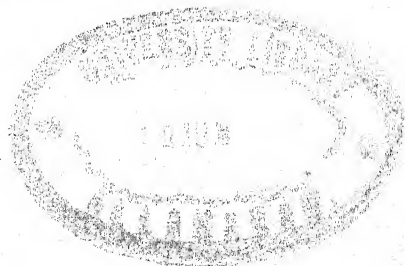
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Family EPHEMERACEAE.

Exceedingly minute and inconspicuous plants, *practically stemless* and *growing on soil from a persistent, much branched protonema, consisting mainly of a bud-like cluster of leaves*, very narrow and costate or ecostate; inside the leaves are borne the subglobose nearly sessile capsules. Dioicous: capsules cleistocarpous in *Ephemerum*, opening along a definite differentiated line in *Nanomitrium*, vaginula relatively large, ovoid-cylindric; stomata, when present, superficial; columella usually absorbed at maturity; peristome lacking; spores large, often rough; calyptra small, mitrate-campanulate, often cleft on one side, usually persistent.

These plants are so small that they are best found by looking for the patches of green protonema. This is distinguished from most algae by its profuse branching. It is generally agreed that the plants of this family are degenerate rather than primitive. Their nearest relationship seems to be with the *Funariaceae*.

Capsules with rudimentary operculum; exothecium of a single layer of cells with no stomata. *Nanomitrium*.
Capsules cleistocarpous; exothecium of two layers of cells, stomata present. *Ephemerum*.

1. EPHEMERUM Hampe, Flora 20: 285. 1837.

Characters of the family and those mentioned in the key; leaves narrowly ovate-lanceolate to nearly linear, costate or ecostate, more or less contorted when dry; leaf cells rectangular to oblong-hexagonal; capsules apiculate (except *megalosporum*); spores large, up to 80 μ , rough. Standard species *E. serratum*.

The leaves do not seem to reach full size until the spores are nearly ripe, as many immature plants with smaller leaves are found mixed with mature plants fully developed, this variation has caused much confusion. In addition the different species have an annoying habit of growing intermingled, and as they cannot be distinguished after drying except by the use of the compound microscope, this often leads to great confusion.

KEY.

- | | |
|---|---------------------------|
| 1. Leaves ecostate. | 2. |
| Leaves with costa. | 3. |
| 2. Leaves only slightly serrulate. | 2. <i>megalosporum</i> . |
| Leaves strongly serrate to spinose on the margins. | 1. <i>serratum</i> . |
| 3. Leaves nearly or quite entire. | 4. <i>sessile</i> . |
| Leaves plainly and often strongly serrate. | 4. |
| 4. Neither leaves nor calyptra papillose. | 3. <i>cohaerens</i> . |
| Leaf cells and costa more or less papillose, often the calyptra also. | 5. |
| 5. Leaves subulate-lanceolate, all upper cells papillose-spinulose on both sides. | 6b. var. <i>texanum</i> . |
| Leaves long-lanceolate to linear. | 6. |
| 6. Leaves very narrow, often linear; costa excurrent into a long coarsely spinose hair point. | 6. <i>spinulosum</i> . |
| Leaves narrowly lanceolate but much broader at base; costa percurrent or excurrent, toothed above but scarcely spinose. | 5. <i>crassinervium</i> . |

1. EPHEMERUM SERRATUM (Hedw.) Hampe, Flora 20: 285. 1837.

Phascum serratum [Schreb.] Hedw. Sp. Musc. 23. 1801.

Protonema abundant; leaves lanceolate, upper erect, reaching 1.4 mm. or more in length, lower much smaller, *all spinose-serrate on the margins to below the middle, with coarse, often recurved teeth; costa entirely lacking*; leaf cells rhomboid-hexagonal, rectangular at base, 15-20 μ wide, 5-6 : 1. Capsules shining red-brown, subglobose, short-apiculate; calyptra reaching the middle of the capsule; spores 50-70 μ , globular to kidney-shaped, warty, maturing winter to spring. Type locality, European.

ILLUSTRATIONS:—Bry. Eur. *pl.* 1; Braithw. Brit. Moss Fl. 1: *pl.* 27A; M. H. M. f. 67.

EXSICCATI:—Aust. Musc. Appal. 47b.

On moist bare soil; New York, New Jersey, Pennsylvania, N. Carolina, Ohio, California; apparently rare and local.

1a. Var. MINUTISSIMUM (Lindb.) n. comb.

Ephemerum minutissimum Lindb. Manip. Musc. 2: 411. 1871-74.

Ephemerum serratum var. *angustifolium* Schimp. Syn. (Ed. 1) 5. 1860. (In part, not of Bry. Eur. *pl.* 1. 1837, which was from Sardinia).

Leaves narrower, only 4-8 cells wide, mostly less than 1 mm. long; leaf cells 90-120 x 20-30 μ ; spores said to be a little smaller and less roughened. *Pl.* 27.

Roth, Ausser-eur. Laubm. 233, states that the type of Lindberg's *minutissimum* is from Cambridge, Massachusetts (James). This type has been seen, also Drummond's specimens from Saskatchewan, both have the appearance of dwarf *serratum* and have long spinose marginal teeth, while the Sardinian specimens figured in the Bry. Eur. and copied in M. H. M. are almost entire. The English plant figured by Braithwaite seems to be the same as the American. Other European plants give a good range of intergradation. The *serratum* from California is much less strongly serrate than the other American *serratum* or its variety.

2. EPHEMERUM MEGALOSPORUM (Aust.) Salm. Journ. Linn. Soc. 34: 166. 1899.

Micromitrium megalosporum Aust. Musc. Appal. 47. 1870.

Leaves lanceolate, slightly concave, broadest of the genus, erect-open when moist, upper reaching 0.6-1 x 0.36 mm., ecostate, *entire or margin slightly irregular by protruding cells*; median leaf cells rectangular, rhomboidal or oblong-hexagonal, about 30 μ wide, 3-6 : 1. Vaginula large, calyptra small; capsule nearly spherical with a small apical protuberance, about 0.35 mm. in diameter, shining chestnut color when ripe; *stomata in upper half of exothecium*; *spores spherical (60 μ) to kidney-shaped (50 x 75 μ)*, finely papillose, mature winter to early spring. Type locality, New Jersey.

ILLUSTRATIONS:—Sull. Icones Suppl. *pl.* 11; Roth. l. c. *pl.* 24, f. 9; *Pl.* 26.

EXSICCATI:—Aust. l. c.; Holzinger, Musc. Acro. Bor. Am. 326; Grout, Musci Perfecti 238.

On moist bare soil, Connecticut and New Jersey to Florida, apparently rare in the north, frequent in Manatee Co., Florida, around the edges of partially dried pools and associated with *E. crassinervium* and *E. spinulosum*.

Under the lens the fresh specimens remind one of a nest containing one egg. Salmon considers this species somewhat intermediate between this genus and the next. The capsules are not regularly dehiscent although so shown by Sullivant. The capsule wall is of two layers of cells and stomata are present, characters of this genus.

The Florida plants described above are larger than Austin's New Jersey plants, but Austin's 47 in my set is immature.

3. EPHEMERUM COHAERENS (Hedw.) Hampe, Flora, l. c. 1837.

Phascum cohaerens Hedw. Sp. Musc. 25. *pl.* 1, f. 1-6. 1801.

Plants often closely gregarious; leaves *broadly lanceolate to oblong-lanceolate*, the upper 1.2-1.5 mm. long, reaching 0.38 mm. wide, erect-spreading when moist, slenderly and often abruptly acute to acuminate, serrate above; costa percurrent or ending just below the apex, stronger above, often toothed on the back; *upper leaf cells short, 35-50 μ long, 2-4 : 1*, oblong to rhomboid-hexagonal. Capsule subglobose, obtusely apiculate, chestnut colored, 0.4 x 0.35 mm.; stomata scattered over the whole capsule; calyptra lobed or torn at base; spores 50-70 μ in diameter, warty, mature late autumn to winter. Type locality, European.

ILLUSTRATIONS:—Bry. Eur. *pl.* 1; M. H. M. f. 65; Braithw. Brit. Moss Fl. 1: *pl.* 27D.

EXSICCATI:—Sull. & Lesq. Musc. Bor. Am. (Ed. 1) 23, (Ed. 2) 29; Sull. Musc. Allegh. 210; Drumm. Musc. Am. S. States 4 and No. 3 (as *Phascum crassinervium* var. *stenophyllum*).

On moist clay or sandy soil; eastern North America, south to Louisiana, west to Ohio. The Lesq. & James Manual says this is common, but the number of collections made in the last fifty years is small. Both this species and *E. serratum* often have the leaves more slenderly acuminate than the illustrations indicate.

Var. FLOTOWIANUM (Funck) Hampe, l. c.

Ephemerum Flotowianum Funck in Brid. Bryol. Univ. 1: 751. 1826.

Costa strongly excurrent in some leaves.

San Marcos, Texas (Wright, 1869) in Herb. Sullivant; New Haven, Connecticut (Nichols, Oct. 1909).

4. EPHEMERUM SESSILE (Br. & Sch.) Rabenh. in Sturm, Deutsch. Krypt. Fl. 2³: 85. 1848.

Also C. Muell. Syn. 1: 33. 1848.

Phascum sessile Br. & Sch. in Pollichia 2: 49. 1844.*Phascum crassinervium* Bry. Eur. fasc. 1. pl. 2. 1837 (not of Schwaegr. 1811).*Ephemerum stenophyllum* Schimp. Syn. (Ed. 1) 5. 1860 (not of Voit, 1813, according to Limpricht, 1: 169).

Rather larger than *E. serratum*, with longer leaves, 2 mm. with leaves; upper leaves lanceolate-subulate, gradually tapering to a slender point, entire or rarely slightly serrulate, 1.8 x 0.18–0.24 mm.; costa pale and thin at base (about $\frac{1}{3}$ the width of leaf base), stout and excurrent above; leaf cells at base elongated rectangular; median smaller, irregularly rhomboidal, 40 x 8 μ , somewhat incrassate. Capsule ovoid, with a blunt apex, 0.44 x 0.34 mm.; calyptra lacerate at base; stomata scattered over the whole capsule; spores 56–80 μ , sometimes kidney-shaped, coarsely warty, mature late autumn to winter. Type locality, Germany.

ILLUSTRATIONS:—Bry. Eur. 1. c.; Braithw. l. c. pl. 27E; Dix. & James. Handb. Brit. Mosses (Ed. 3) pl. 36C; Pl. 28.

No American specimens have been located. Sull. & Lesq. Musc. Bor. Am. (Ed. 1) 21 is *E. spinulosum*.

5. EPHEMERUM CRASSINERVIUM (Schwaegr.) C. Muell. Syn. 1: 33. 1849.

Phascum crassinervium Schwaegr. Suppl. 1: 4. pl. 2. 1811 (not of Bry. Eur.).

Leaves erect-spreading, flexuous, linear-lanceolate, reaching 1.4 x 0.35 mm., usually narrower, slenderly acuminate and coarsely serrate above; costa often not apparent near the base, excurrent in all except the lower leaves, toothed on all sides; leaf cells irregular, oblong to oblong-hexagonal, reaching 120 x 15 μ , more or less papillose near apex. Calyptra cleft-lobate, conic, covering about $\frac{1}{4}$ of the capsule; capsules ovoid, apiculate, about 0.6 mm. high; stomata scattered in all parts of the capsule wall; spores irregularly oblong, \pm 50 x 75 μ , papillose to warty, mature in late autumn to early spring, winter in Florida. Type locality, probably Pennsylvania.

ILLUSTRATIONS:—Sull. Icones Musc. pl. 8; M. H. M. f. 66.

EXSICCATI:—Sull. Musc. Allegh. 209; Aust. Musc. Appal. Suppl. 456; Grout, Musci Perfecti 237.

On moist soil, usually on that which is overflowed at high water; Connecticut to Florida, west to Ohio and Illinois. I do not find the calyptra covering so much of the capsule as represented by Sullivan nor do I find the capsule so nearly spherical. The ovoid capsule, narrower leaves and longer leaf cells distinguish this easily from *E. cohaerens*. Holzinger's Musc. Acro. Bor. Am. 126, which is figured by Roth, Ausser-eur. Laubm. pl. 23, is not at all typical; I should refer it to var. *papillosum*, a form intermediate between *crassinervium* and *spinulosum*. *Spinulosum* seems to be the basic form of this group, occurring almost everywhere in the eastern U. S. and southeastern Canada.

Roth, Ausser-eur. Laubm. 231–232, states that Sullivan's specimen sent Schimper in 1842 and published by him as *E. pallidum* in Syn. (Ed. 1) 5. 1860, is close to a small form of *crassinervium* and he does not consider it worthy of specific rank.

Var. PAPILLOSUM (Aust.) R. & C. Musc. Am. Sept. 266.

Ephemerum spinulosum Aust. Musc. Appal. 50. 1870.

Austin's no. 50 differs from *crassinervium* in little except a strongly papillose calyptra, which seems to be a variable character in this group as specimens of typical *crassinervium* have the cells of the calyptra strongly bulging or mammillose and specimens of *E. spinulosum* in the Yale herbarium marked TYPE by Mrs. Britton have the calyptra as papillose as in Austin's 50. Austin's 50 has the costa more excurrent than Sullivan's figures and descriptions, but Cardot, Bull. Herb. Boiss. 7: 362 says Schwaegrichen's plants have the costa strongly excurrent, which is the case in all specimens examined.

Type locality, Palisades, New Jersey. Connecticut to North Carolina, west to Illinois and Minnesota. The smaller size (27–35 μ) of the spores in Austin's type is presumably due to their immaturity.

ILLUSTRATIONS:—Sull. Icones Musc. Suppl. pl. 10; Roth, l. c. pl. 23. f. 7; Pl. 26.

6. EPHEMERUM SPINULOSUM Schimp. Syn. (Ed. 1) 6. 1860.

Phascum crassinervium "var.," Sull. Mosses U. S. 14. 1856.*Phascum serratum* var. *angustifolium* Drumm. Musc. Am. S. States no. 2 (in part).

Leaves very narrow throughout, almost linear, 1-1.3 mm. long, about 60-150 μ wide at base; costa usually strong, nearly $\frac{1}{2}$ the leaf base, but variable, sometimes disappearing near the insertion, excurrent into a long spinulose awn with spines on all sides and down the back, and also on the upper leaf cells, spines sometimes reaching 60 μ in length but mostly shorter; median leaf cells 35-80 μ long, 4-8 : 1, oblong to rectangular; stomata few, mostly below middle of capsule; capsule and spores scarcely different from those of the preceding; calyptra smooth to papillose. Type locality, Louisiana (Drummond).

ILLUSTRATIONS:—Roth, Ausser-eur. Laubm. pl. 21, f. 5; Cardot, Bull. Herb. Boiss. 7: pl. 7, f. 3; Pl. 27.

EXSICCATI:—Sull. & Lesq. Musc. Bor. Am. (Ed. 1) as *E. crassinervium* (at least in part); Aust. Musc. Appal. 48 & 49 (as *crassinervium*); Grout, Musci Perfecti 11; Holzinger, Musc. Acro. Bor. Am. 126 & 351; Macoun, Can. Musci 465 (as *E. serratum* var. *minutissimum*).

Cardot's figure illustrates the spinose apex very well but the base is as wide as in *crassinervium*; this figure well represents Holzinger's Musc. Acro. Bor. Am. 126, which is an intermediate form. This was issued as *E. crassinervium* and was mistakenly used by Roth, l. c. pl. 23, f. 10 to illustrate that species. Cardot's figures, l. c. figs. 1 & 2 well illustrate the leaves of *crassinervium* and its variety *papillosum*. Roth's figures of this species fit the type almost exactly. Typical *E. crassinervium* is a form with relatively broad leaves, coarsely serrate and toothed above; *E. spinulosum* is typically the form with linear strongly spinose leaves. As I have collected them in Florida they are distinct enough to be distinguished with a hand lens in the field but several northern collections are intermediate.

Minnesota and Ontario to Quebec, south to the Gulf.

Attached to the protonema in several specimens were rhizome-like, dark-brown bodies, also giving off rhizoids, that probably carry the plants over from season to season.

6a. Var. *HYSTRIX* (Lindb.) n. comb.

Ephemerum hystrix Lindb. Manip. Musc. 2: 411. 1874.

Costa lacking in some leaves and only in the upper half in others.

ILLUSTRATIONS:—Roth, l. c. pl. 24, f. 4.

EXSICCATI:—Drumm. Musc. Am. S. States, no. 2 in part; the type (As *E. serratum* var. *angustifolium*); Louisiana; Florida (Rapp).

6b. Var. *TEXANUM* n. var.

Folia lanceolata subulata, suberecta, utra pagina spinulosa; costa percurrens vel excurrent, basi haud raro subevanida.

Leaves lanceolate-subulate, slenderly acuminate, erect-spreading to infolded, about 0.7 mm. long, reaching 1 mm. occasionally; costa often vanishing at base, stronger and often excurrent at apex; entire leaf spinulose-papillose above the middle on the margins and both surfaces, upper cells oblong to rhombic, 2-3 : 1; basal cells smooth, 10-20 μ wide, 3-5 : 1. Capsules subglobose, bluntly apiculate, about 0.36 mm. in diameter; calyptra papillose; spores 60-80 μ in diameter, papillose, mature in winter. Type, Grout, Musci Perfecti 275 from Texas (McAllister). Also collected along the Santee Canal, S. Carolina (Ravenel no. 196). Pl. 27.

2. **NANOMITRIUM* Lindb. Notis. Sällsk. Fauna et Fl. Fenn. fasc. 13: 408. 1874.

Micromitrium Aust. Musc. Appal. with no. 45. 1870 (not of Spruce 1867).

Ephemerum grandifolium C. Muell. Bull. Herb. Boiss. 6: 20. 1898.

Differs from *Ephemerum* as noted in the key p. 67. The calyptra is minute and the leaves ecostate. Type species, *N. Austinii*.

KEY.

Leaves serrulate; calyptra central..... 1. *Austinii*.
Leaves entire; calyptra often excentric..... 2. *synoicum*.

1. *NANOMITRIUM AUSTINII* (Sull.) Lindb. l. c.

Micromitrium Austinii Sull. in Aust. Musc. Appal. 45. 1870.

Ephemerum grandifolium C. Muell. Bull. Herb. Boiss. 1898: 20.

Plants with very short stems, 0.1 mm. long; leaves ligulate-lanceolate, reaching 1 x 0.16 mm., mostly shorter, slightly serrulate above by projecting cell angles, ecostate; leaf cells mostly oblong-hexagonal, 18-24 x

80-150 μ . Synoicous; calyptra small, central; capsules nearly sessile, spherical, 0.18 x 0.24 mm.; spores globular to kidney-shaped, 24-30 μ in diameter, finely and irregularly roughened. Type locality, Closter, New Jersey.

ILLUSTRATIONS:—Sull. Icones Musc. Suppl. *pl.* 12; M. H. M. *f.* 63; Roth, l. c. *pl.* 24, *f.* 2.

EXSICCATI:—Aust. l. c.; Holz. Musc. Acro. Bor. Am. 268.

On moist shaded soil and mud, rare; New Jersey and New York (Austin), Staten Island, N. Y. (Grout), Connecticut (Nichols), Florida (Rapp). Easily distinguished from *Ephemerum megalosporum* by the smaller nearly smooth spores. I have seen specimens of *E. grandifolium* from the type locality and identified by Mueller.

Var. FLORIDANUM n. var.

Nanomitrium grandifolium Holz. Musc. Acro. Bor. Am. 376.

Plantae majores, folia plus minusve 1 x 1.03 mm.; sporae majores et scabrae.

Plants larger; leaves reaching over 1 mm. by 0.3 mm., spores a little larger, rough.

EXSICCATI:—Holz. l. c.; Grout, Musci Perfecti 289, the type.

A specimen from Camden, N. J. Nov. 1858 (Lanning) is as large as the Florida plants but has spores like *Austinii*.

2. NANOMITRIUM SYNOICUM (James) Lindb. l. c.

Ephemerum synoicum James, Trans. Am. Phil. Soc. 9: 106. 1865.

Differs from *Austinii* in having a short distinct stem reaching 0.65 mm. in length; leaves more erect, linear-lanceolate, narrower, at least in the upper part, entire; leaf cells more inclined to be rectangular; capsules a little larger (often 2 from the same perichaetium), reaching 0.3 mm. in diameter; calyptra often excentric; spores 28-38 μ in diameter, warty, mature in autumn.

Type locality, around Camden, New Jersey and across the Delaware river near Philadelphia. Also found in Swedesboro, N. J. (Kaiser). Specimens from Emma, Missouri (Demetrio) have the leaves slightly serrate at the extreme apex.

ILLUSTRATIONS:—Sull. Icones Musc. Suppl. *pl.* 13; Roth, l. c. *pl.* 22, *f.* 4; *Pl.* 26.

EXSICCATI:—Aust. Musc. Appal. 46; Holzinger, Musc. Acro. Bor. Am. 327; Sull. & Lesq. Musc. Bor. Am. (Ed. 2) 27.

Family DISCELIACEAE Schimp.

Gregarious annual mosses with persistent perennial protonema; plants very short, almost stemless and resembling buds; leaves sheathing, faintly costate in the upper part, acute, entire, with plane margins-1.3-1.8 mm. long, the inner the larger, ovate to oblong-lanceolate, with little chlorophyll; leaf cells oblong, hexagonal to elongated-rhomboidal, longer and linear near the margin, thin-walled, smooth, median about 120-150 μ long, 5-8:1. Dioicous; male plants bud-like; calyptra split partially on one side and usually remaining attached to the seta below the capsule; seta stiff, 1-2 cm. long, red or chestnut in color; capsule small, ovoid-globose, 1 mm. or more in length, cernuous to horizontal by the bending of the short neck, smooth, without stomata; operculum relatively large, convex-conic; peristome inserted below the mouth, single, teeth 16, linear-lanceolate, acute, usually perforate below to nearly split longitudinally, striate on the outside; annulus present; spores in spring; reproducing by the persistent protonema and tuberculate brood bodies on the rhizoids. Only one genus and one species known.

DISCELIUM Brid. Bryol. Univ. 1: 365. 1826.

DISCELIUM NUDUM (Dicks) Brid. l. c.

Bryum nudum Dicks. Crypt. Fasc. 4: 7. *pl.* 10, *f.* 15. 1801.

Discelium incarnatum (Schwaegr.) Jennings, Mosses W. Pennsylvania 126. 1913.

Characters of the family. Type locality, Germany.

* See Nichols, Notes on Connecticut Mosses, Rhodora, 12: 146-150.

ILLUSTRATIONS:—Bry. Eur. *pl.* 297; Braithw. Brit. Moss. Fl. 2. *pl.* 64A; *Pl.* 28.

EXSICCATI:—Aust. Musc. Appal. Suppl. 505; Holzinger Musc. Acro. Bor. Am. 508; Grout, Musci Perfecti 29.

On bare clayey soil, rare; Illinois, Pennsylvania, Ohio, New Jersey; also in Europe and Asia.

Brotherus in Engler & Prantl (Ed. 2) 10: 316 states that there are rudiments of an inner peristome, but I have not seen them and no one has figured them. The leaf structure resembles that of the Funariaceae except for the faint costa. Apparently the protonema dries up and is scarcely visible in the dry season. It should be sought for in the early spring soon after the snows melt, at which time the protonema is said to be conspicuous.

Family FUNARIACEAE.

Plants annual or sometimes biennial, rather small and light-green as a rule, growing on soil that is bare or sparsely covered by other vegetation, simple or sparingly branched, erect, bearing rhizoids at base only; mostly with a central strand; *upper leaves wide, soft and more or less closely clustered and erect-open*, more or less concave; margins plane or incurved, often serrate above, marginal cells mostly narrower but rarely forming a distinct border; *costa strong*, nearly percurrent to shortly excurrent; *leaf cells parenchymatous*, large, $\pm 30 \mu$ in width, oblong-hexagonal above, longer and rectangular at base, thin-walled, never papillose.

Monoicous with few exceptions; capsules immersed to exserted on long setae, globose to pyriform, symmetric to strongly curved and cernuous; peristome lacking, single, or double; teeth when present 16, obliquely dextrorse, strongly trabeculate; *segments if present opposite the teeth with no basal membrane or cilia*; stomata numerous, on the capsule neck or base; operculum hemispheric to conic, often apiculate but not beaked; calyptra large, smooth, often inflated, usually with a long beak, cucullate or often split in two or more places at base.

KEY.

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| Capsules strongly unsymmetric and curved, peristome usually present | 5. <i>Funaria</i> . |
| Capsules erect and symmetric or nearly so | 2. |
| 2. Capsules immersed | 3. |
| Capsules exserted or at least $\frac{3}{4}$ emergent | 4. |
| 3. Capsules with a distinct operculum, distinctly smaller than the rest of the capsule | 3. <i>Physcomitrium</i> sp. |
| Capsules splitting at the equator or irregularly dehiscent | 1. <i>Aphanorhegma</i> . |
| 4. Seta about the length of the capsule; calyptra 4-angled | 2. <i>Pyramidula</i> . |
| Seta much longer than the capsule | 5. |
| 5. Peristome double | <i>Funaria</i> . |
| Peristome single or lacking | 6. |
| 6. Peristome present, single, rarely with a very rudimentary inner peristome . . . | 4. <i>Entosthodon</i> . |
| Peristome entirely lacking | 3. <i>Physcomitrium</i> . |

1. APHANORHEGMA Sull. in Gray's Manual (Ed. 1) 647. 1848.

Minute plants, gregarious to cespitose, including leaves 1–5 mm. high, from a rather scanty protonema; leaves erect-spreading, contorted when dry and more or less shriveled, larger and crowded above, lanceolate to oblong-obovate, serrulate above by projecting cells; costa usually ending below the apex, sometimes percurrent; leaf cells large, thin-walled and parenchymatous. Monoicous; seta very short; *capsules immersed, globular, apiculate, dehiscing along the median line or sometimes irregularly*; stomata at base of capsule; peristome and annulus lacking; calyptra mitrate or campanulate, naked. Type species *A. serratum*.

KEY.

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| Exothelial cells strongly collenchymatous, line of dehiscence clearly marked | 1. <i>serratum</i> . |
| Exothelial cells thin-walled, not collenchymatous; line of dehiscence not clearly marked as a rule | 2. <i>patens</i> . |

APHANORHEGMA SERRATUM (Hook. & Wils.) Sull. l. c.

Schistidium serratum Hook. & Wils. in Drumm. Musc. Am. S. States no. 20. 1841.

Plants light green, growing more or less thickly clustered; upper leaves oblong-lanceolate to oblong-obovate, acute to acuminate; margins plane and serrulate above, costa ending in or just below the apex;

basal rectangular cells somewhat swollen, thin-walled; upper median hexagono-rectangular, about 2.5-3 mm. wide. Calyptra campanulate-mitrate, 4-6 lobed, covering upper $\frac{1}{4}$ of the capsule; seta about 0.2 mm. long; capsules immersed, light brown, nearly or quite globose, up to 0.75 mm. in diameter; *dehiscing along a row or two of smaller cells along the equatorial line; exothecial cells strongly collenchymatous* except at base, quadrate; spores 22-30 μ , papillose-spinose, mature in autumn.

Type locality, near St. Louis, Missouri.

ILLUSTRATIONS:—Sull. Icones Musc. *pl.* 57; Jennings, Mosses Western Pa. *pl.* 16; Bull. Torr. Bot. Club 22: *pl.* 230; *Pl.* 29.

EXSICCATI:—Drumm. Musc. Am. S. States 20; Sull. Musc. Allegh. 198; Sull. & Lesq. Musc. Bor. Am. (Ed. 1) 24 (as *Physcomitriella patens*) and 154; Aust. Musc. Appal. 178; Holz. Musc. Acro. Bor. Am. 193. The Sull. & Lesq. (Ed. 2) 29 in the Yale herbarium is this species.

On damp clayey soil, northern and middle U. S., west to Iowa, south to Alabama and Missouri. Not reported from northern New England or Canada.

Distinguished from *Physcomitrium immersum* and *A. patens* by the strongly collenchymatous exothecial cells, which are well developed long before the spores are ripe. Mrs. Britton in Bull. Torr. Bot. Club 22: 65. *pl.* 231 describes a hybrid of this species, presumably with *Physcomitrium turbinatum*, found in Drummond's no. 20. In this some capsules are typical, others are exerted and like those of the *Physcomitrium*, both kinds on the same plant.

APHANORHEGMA PATENS (Hedw.) Lindb. Öfv. Vet.-Akad. Förh. 580. 1864.

Phascum patens Hedw. Sp. Musc. 20. 1801.

Physcomitriella patens Bry. Eur. *pl.* 3. 1849.

When sterile scarcely to be distinguished from the preceding: costa as a rule ending a little farther below the leaf apex; capsule *not regularly dehiscient along the equatorial line, but sometimes opening in this manner*; in some cases the equatorial cells are certainly transversely elongated; capsules sometimes with a somewhat longer seta: *exothecial cell walls very thin, not collenchymatous*; calyptra not lobed; spores apparently ripening a little earlier and rather more sharply spinose. Type locality, "Rosenthal bei Leipzig."

ILLUSTRATIONS:—Bry. Eur. l. c.; Braithw. Brit. Moss Fl. 2: *pl.* 64D; Bull. Torr. Bot. Club. l. c. *pl.* 230; *Pl.* 29.

EXSICCATI:—Holz. Musc. Acro. Bor. Am. 442; Drumm. Musc. Am. S. States 5; Sull. & Lesq. Musc. Bor. Am. (Ed. 2) 30.

Habitat similar to that of *serratum*; Montreal; Pennsylvania; Syracuse, N. Y.; Ohio; Missouri; Minnesota; apparently rare or overlooked. Andrews, Torrey 18: 52. 1918, describes a hybrid of this species with *Physcomitrium turbinatum*.

2. PYRAMIDULA Brid. Musc. Recent. Suppl. 4: 20. 1819.

One species only. Distinguished from *Physcomitrium* chiefly by the large 4-angled calyptra entirely covering and inclosing the emergent or barely exerted capsule, split on one side.

PYRAMIDULA TETRAGONA (Brid.) Brid. l. c.

Gymnostomum tetragonum Brid. l. c. Suppl. 1: 270. 1806.

Physcomitrium tetragonum Bry. Eur. fasc. 11: *pl.* 298. 1841 and Fühnr. Flora, 1829.

Small annual plants, densely to loosely cespitose; stems simple, about 1 mm. high; central strand present; lower leaves much smaller, the upper 1-1.5 mm. long, suberect and bud-like, contorted when dry, ovate to oblong-ovate, rather abruptly long-acuminate, concave with plane margins, entire; costa ending in the acumination or excurrent into the slender apex; leaf cells large, thin-walled, smooth, the lower $\pm 18 \mu$ wide, 2-4 : 1, the upper rhombic-hexagonal. Monoicous, antheridial buds at base of stems; seta 1-2 mm. long, from slightly shorter than the perichaetial leaves to slightly longer; capsule erect and symmetric, globose-pyriform, narrowed at the mouth, which is bordered by about 6 rows of transversely elongated cells; operculum small, mammillate-apiculate; annulus lacking; stomata in the neck, unicellular, with a long and narrow opening; peristome lacking; spores 45-70 μ in diameter, nearly or quite smooth, maturing in early spring. Type locality, Germany.

ILLUSTRATIONS:—Bry. Eur. l. c.; Limpricht, Laubmoose 2: 178, f. 260; Husnot, Musc. Gall. *pl.* 57; *Pl.* 28.

EXSICCATI:—Holzinger, Musc. Acro. Bor. Am. 194.

On soil; Texas, Indiana, Colorado, Minnesota; rare.

3. *PHYSCOMITRIUM* Brid. Bryol. Univ. 1: 97. 126 (as subgenus) and 2: 815. 1827 (as genus).

Mostly small plants with leaf characters of the family; mostly larger than *Aphanorhegma*; leaves oblong, obovate, spatulate or broadly oblanceolate; capsule immersed or on a long seta, erect, symmetric, with a distinct operculum but no peristome; collum short and thick; annulus of small cells, persistent, or larger and falling in fragments; operculum large, convex to conic-apiculate; spores large, papillose to spinose; calyptra long and symmetrically rostrate, lobed at base.

Type species *P. sphaericum* (Ludw.) Brid.

The length of seta in this genus is exceedingly variable according to climate and soil conditions. This has led to great confusion. The capsule mouth in *P. turbinatum* and its varieties seems to widen with age.

KEY.

- | | |
|--|--------------------------|
| 1. Seta not longer than the perichaetial leaves..... | 2. |
| Seta clearly longer than the perichaetial leaves..... | 5. |
| 2. Capsules deeply immersed..... | 8. <i>immersum</i> . |
| Capsules at least $\frac{2}{3}$ emergent..... | 3. |
| 3. Leaves oblong-lanceolate, rather slenderly acuminate..... | 4. |
| Leaves broadly ovate, acute to short-acuminate..... | 7. <i>coloradense</i> . |
| 4. Costa never excurrent; spores $\pm 30 \mu$ in diameter..... | 4. <i>pygmaeum</i> . |
| Costa excurrent in all the upper leaves; spores $\pm 40 \mu$ | 2. <i>Kellermani</i> . |
| 5. Costa excurrent in the upper leaves..... | 6. |
| Costa rarely excurrent..... | 7. |
| 6. Spores $\pm 40 \mu$ in diameter; leaves mostly serrate above..... | 3. <i>Kellermani</i> . |
| Spores 20-30 μ ; leaves mostly entire..... | 4. <i>acuminatum</i> . |
| 7. Leaves nearly or quite entire; seta but little longer than the perichaetial leaves;
annulus very large, vesicular..... | 6. <i>Hookeri</i> . |
| Leaves entire or serrate above; seta several times the length of the perichaetial
leaves; annulus narrow..... | 8.* |
| 8. Stems tall, leafy and branching, ± 2.5 cm..... | 1. <i>varieties</i> . |
| Stems usually ± 1 cm..... | 9. |
| 9. Leaves mostly entire; capsules urceolate when dry, not flaring at the mouth..... | 2. <i>megalocarpum</i> . |
| Leaves mostly serrate; capsules turbinate and flaring at the mouth when dry..... | 1. <i>turbinatum</i> . |

1. *PHYSCOMITRIUM TURBINATUM* (Mx.) Brid. Bryol. Univ. 2: 815. 1827.

Gymnostomum turbinatum Mx. Flor. Bor. Am. 2: 286. 1805.

Gymnostomum dilatatum P. B. Prod. 59. 1805.

Gymnostomum splachnoideum P. B. Prod. 59. 1805.

Gymnostomum Physcomitrium tortipes Brid. Bryol. Univ. 1: 100. 1826.

Physcomitrium turbinatum Muell., Lesq. & James Man. 198. 1884.

Physcomitrium strangulatum Kindb. Ottawa Naturalist 4: 62. 1889.

Physcomitrium pyriforme of American authors, not of Bridel.

Physcomitrium platyphyllum Kindb., Macoun Cat. Can. Pl. 6: 269. 1892.

Plants exceedingly variable according to conditions of light and moisture, light green, gregarious; stems 3-12 mm. in height, short and simple or taller and branching, rather loosely foliate; leaves 3-5 mm. long, oblong-oblanceolate or obovate-lanceolate, acuminate, serrate above the middle, plane and spreading when moist, contorted when dry; costa ending in or below the apex or occasionally very shortly excurrent; lower leaf cells oblong, upper shorter, rhomboidal to oblong-hexagonal, marginal longer and narrower. Calyptra cucullate and unequally lobed at base, oblique and rostrate; seta 5-15 mm. long, with few exceptions erect; capsule erect and symmetric, 1-2 mm. long, globose-pyriform when fresh; when dry and empty turbinate and constricted below the mouth and below the spore sac, becoming brown and often more or less urn-shaped with age; operculum convex, mamillate to apiculate; capsule mouth bordered by 8-12 rows of smaller transversely elongated cells, 20-25 μ wide and a narrow fringe of one to three rows of smaller cells, above

* *pygmaeum* may be sought here.

these an annulus of large incurved cells; spores strongly papillose, 27-40 μ , mature in spring. Type locality, S. Carolina.

ILLUSTRATIONS:—Jennings, Mosses Western Pa. *pl.* 16; Bull. Torr. Bot. Club, *pl.* 198; M. H. M. f. 96; *Pl.* 30.

EXSICCATI:—Sull. & Lesq. Musc. Bor. Am. (Ed. 1) 156, (Ed. 2) 234 (both as *P. pyriforme*); Aust. Musc. Appal. 180; Holzinger, Musc. Acro. Bor. Am. 40, 40b, and 217 (as *P. Drummondii*); Grout, Musci Perfecti 207.

Common on bare earth in all sorts of places and in conservatories. Common in all parts of the U. S. east of the Rockies, also found in southern Canada and west to California. For notes on variations see Mrs. Britton's notes in the Journ. N. Y. Bot. Garden 4: 50. 1901.

1a. Var. LANGLOISII (R. & C.) E. G. B., Bull. Torr. Bot. Club 21: 200. *pl.* 198. 1894.

Physcomitrium pyriforme var. *Langloisii* R. & C. Bot. Gaz. 14: 94. 1889.

Plants slender and simple, sometimes short, sometimes reaching 2 cm. in length; leaves narrow, oblong, distant and much contorted when dry, reaching 5 mm. long; seta filiform, 1-2 cm. long; capsule almost campanulate, rarely contracted below the mouth when dry; spores spinose, mature in winter due to southern range. Type locality, Louisiana (Langlois). Also in Texas and Florida and probably in all the south-eastern states. Forms from New York and New Jersey have been referred to this by the authors. It is typically a southern form. Probably a form developed by conditions of heat and abundant moisture. *Pl.* 30.

EXSICCATI:—Holz. Musc. Acro. Bor. Am. 443, 40b (as the species), 472 (as *P. megalocarpum*).

Forma AUSTRALE (E. G. B.) n. comb.

Physcomitrium australe E. G. B. l. c. *pl.* 199.

Plants reaching 25 mm. long, very lax and often much branched; capsule often cernuous, more subglobose. Type from Apalachicola, Florida, Drummond's Musc. Am. S. States no. 25 as *Gymnostomum tortipes* Hook. *Pl.* 30.

2. PHYSCOMITRIUM MEGALOCARPUM Kindb. Bull. Torr. Bot. Club. 16: 94. 1889.

Plants *largest of the genus*; stems 3-4 mm. high; leaves rosulate at top of stems, plane and erect-spreading, contorted when dry, 3-5 mm. long (5-7 according to Mrs. Britton), oblong-lanceolate to oblong-spatulate, the lower sometimes ovate-lanceolate, acuminate, the upper nearly or quite entire, the lower often serrulate; costa percurrent or ending just below the apex; basal cells rectangular, inflated at the basal angles, 45-55 μ wide, 2-4:1, upper shorter and becoming more or less oblong-hexagonal, *two or more rows of marginal cells linear and yellowish*, shorter toward the apex. *Seta 10-20 mm. long; capsule globose-pyriform, 2-3 mm. long, and about 2 mm. in diameter, narrower at the mouth when moist, when dry urceolate and contracted below the mouth; operculum conic-apiculate; exothecial cells as in P. turbinatum; spores spinose, 27-35 μ , mature April to June.* Type locality, Victoria, Vancouver Island, Macoun, Can. Musci 147.

An especially fine lot in the Canadian National Museum collected at Cedar Hill in the same general locality, May 16, 1887, Can. Musci 210 of Macoun, bears the notation "n. sp. Kindberg" in what looks like Kindberg's handwriting. The capsules on these specimens are beautifully urn-shaped. *Pl.* 33.

On soil; several collections from Vancouver Id.; also collected in Washington, Oregon and California. The leaves as a rule are more slenderly acuminate and more distinctly bordered than in *turbinatum*.

Var. CALIFORNICUM (E. G. B.) n. comb.

Physcomitrium californicum E. G. B. l. c. 206. *pl.* 293.

Plants smaller; stems 2-3 mm. high, leaves 2-3 mm. long; seta 4-14 mm. long (Mrs. Britton says 10-20); capsules nearly globose and slightly or not at all contracted below the mouth when dry, mouth always smaller than the diameter of the capsule. Type from California (Bolander), growing on the ground. Type seen, in the herb. N. Y. Botanical Garden. *Pl.* 31.

Also along the Truckee River, Sierra Co., California, June 24, 1929 (Mrs. MacFadden, no. 9586).

A comparison of Mrs. Britton's descriptions of *P. megalocarpum* and *P. californicum* shows very little difference except in size, which is quite variable.

3. *PHYSCOMITRIUM KELLERMANI* E. G. B. Bull. Torr. Bot. Club 21: 204. *pl.* 200. 1894.

Plants scattered or gregarious, stems 2-5 mm. high, simple or with basal innovations; leaves few, rosulate, the upper 2-2.5 mm. long, lanceolate to ovate-lanceolate, more or less longly acuminate, more or less serrate above, plane; *costa stout, excurrent in the upper leaves*; basal leaf cells 20-24 μ wide, 2-3 : 1, not much longer than the upper, narrower near the margins. Calyptra large, 2-2.5 mm. long, 3-lobed; *seta mostly short*, sometimes shorter than the perichaetial leaves, occasionally twice as long; capsule short-pyriform, contracted below the mouth or broadly flaring when dry, light brown until very old, 1-1.5 mm. long, neck wrinkled, stomatose; mouth bordered by 4-8 rows of transversely elongated cells and a narrow persistent annulus of smaller cells; stomata more or less immersed; operculum conic-rostellate; *spores large, 40-48 μ* , rough, strongly papillose to subspinose, mature in early spring. Type locality, Manhattan, Kansas (Kellerman) 1889 (in herb. N. Y. Botanical Garden); also collected in Nebraska, Iowa, N. Dakota, Alberta, B. C., and Texas.

ILLUSTRATIONS:—Bull. Torr. Bot. Club. l. c.; *Pl.* 33.

EXSICCATI:—Holzinger, Musc. Acro. Bor. Am. 218 & 416 (as *p. pygmaeum*).

Mrs. Britton's original description is good but the plate is very misleading. The large spores and excurrent costa will distinguish it from related species. The variation in the length of the seta and serration of the leaves is often puzzling. In most cases the perichaetial leaves nearly or quite reach the capsule base.

Var. *DRUMMONDII* (E. G. B.) n. comb.

Physcomitrium Drummondii E. G. Britton, Bull. Torr. Bot. Club 21: 205. *pl.* 201. 1894.

Physcomitrium Hookeri var. *serratum* R. & C. Rev. Bryol. 19: 93. 1892.

Differs from *P. Kellermani* in the following particulars: leaves broader, costa usually ending below the leaf apex, rarely short-excurrent (an exceedingly variable character in this section of the genus); seta usually more than twice the length of the perichaetial leaves (also quite variable). *Pl.* 28.

EXSICCATI:—R. & C. Musc. Am. Sept. 44. Extending north to Belleville, Canada, and Oregon; Missouri (Bush).

The difference in the leaf margins indicated in the original description does not hold in the type and is quite variable on the same plant at times. Both types have been studied through the courtesy of R. S. Williams and the New York Botanical Garden. I am unable to find any constant capsule differences. Type locality, near New Orleans, Drumm. Musc. Am. S. States, no. 24 "P. pyriforme, var. 3."

4. *PHYSCOMITRIUM ACUMINATUM* (Schleich.) Bry. Eur. fasc. 11. *pl.* 300. 1841.

Gymnostomum acuminatum Schleich. Cat. Pl. Helv. 4: 40. 1821.

Plants gregarious, pale green, smaller than most forms of *P. turbinatum*; stems short, 2-3 mm. high, simple or divided; leaves rosulate, erect-open when moist, somewhat contorted when dry, oblong-lanceolate, rather slenderly acuminate, 2-3 mm. long, *entire* or rarely somewhat serrulate above, often somewhat concave; *costa stout, almost percurrent to short-excurrent*; leaf cells about as in *P. turbinatum*, the two marginal rows noticeably narrower. Calyptra small, about 2 mm. long, lobed; seta pale, 6-13 mm. long; operculate capsules 1.5-2 mm. long, pyriform, becoming turbinate when dry; operculum conic-mamillate to conic-apiculate; exothelial cells a little smaller than in *P. turbinatum*, 7-11 rows of transversely narrower cells around the capsule mouth; annulus narrow; spores 20-30 μ , spinose, mature in spring. Type locality, Switzerland.

ILLUSTRATIONS:—Bry. Eur. l. c.; *Pl.* 31.

EXSICCATI:—Holzinger, Musc. Acro. Bor. Am. 216.

On bare moist earth; rare even in Europe. Nebraska, Kansas, Illinois and Nevada (Palmer). Sufficient material has not been available for a comprehensive study of the species. The description has been drawn largely from Holzinger's 216, which does not fully agree with Mrs. Britton's description (Bull. Torr. Bot. Club 21: 202) or that of Limpricht in the Laubmoose. Palmer's plants in the U. S. National Museum, identified by Mrs. Britton, have spores 37 μ in diameter but leaves like *acuminatum*. Holzinger's 216 has leaves and spores much like *acuminatum*, but some of the leaves are markedly serrulate. Other American specimens studied have leaves of *acuminatum* but spores of *turbinatum*. The author does not feel

competent to pass on the European plants but believes American plants would better be regarded as a form of *turbinatum*, with leaves usually more slender, more plainly bordered, more nearly entire, and costa more generally excurrent, and with smaller spinose spores, but with all kinds of gradations.

5. *PHYSCOMITRIUM PYGMAEUM* James, Bot. King's Expedition 404. 1871.

"Plants small, 3-5 mm. high; stems leafy, simple or sparingly branched; leaves longest at the apex, oblong-acuminate, serrulate, vein ending in or below the apex; seta short, almost immersed, twisted to the left, as long as the oblong-pyriform capsule; annulus of two rows of narrow cells, persistent; mouth bordered by 5-7 rows of oblong cells; neck tapering, with few stomata; lid large, conic-apiculate; calyptra lobed and beaked; spores rough, 28-31 μ ," maturing in late spring.

"Utah, Watson, 1869. Only fragments are preserved in Sullivant's herbarium." Type locality, "on the ground above Parley's Park, in the Wahsatch mountains, Utah, at 6,500 feet altitude." *Pl.* 31.

Type in the Farlow Herbarium at Harvard. Also collected in Nevada (Baker), det. Cardot & A. J. G.; Spokane, Washington (Sandberg & Leiberger 851) alt. 1450 ft.

The above description is copied from Mrs. Britton's monograph which has many further interesting notes. The more mature and complete specimens mentioned above furnish the following facts. The upper perichaetial leaves are usually just a little longer than the seta in the immature type specimens, but in the Sandberg specimens, which are characteristic in every other way, the seta is 3 mm. or more in length. The exothecial cell walls in this species seem unusually thick and firm for the genus.

5. *PHYSCOMITRIUM HOOKERI* Hampe, Icon. Musc. 3: pl. 30. 1844.

Gymnostomum latifolium Hook. in Drumm. Musc. Am. 16. 1828 (not of Bridel).

Gymnostomum latifolium Schwaegr. Suppl. 4: pl. 304. 1842.

Physcomitrium latifolium Lindb. Öfv. Akad. 21: 595. 1864.

Physcomitrium hians Lindb. Manip. Musc. 1: 51. 1870.

Plants densely clustered, light to brownish green; stems short, 1-2 mm., sometimes branching by innovations; leaves rosulate, erect-open, *broadly ovate to oblong-ovate, gradually short-acuminate*, 2-2.5 mm. long, plane, entire; costa percurrent or nearly so; upper leaf cells short-rectangular to rhomboidal, $\pm 24 \mu$ wide, the lower rectangular, about 30 μ wide, 2-3:1. Calyptra a little more than covering the operculum, about 3-lobed at base; seta stout, 2-3 mm. long, a little longer than the perichaetial leaves; capsule obovoid, obconic when dry and slightly constricted under the mouth; operculum convex-rostellate; *annulus very large, of about 3 rows of vesicular cells* much as in *Funaria hygrometrica*, more or less persistent; spores slightly papillose, about 25-30 μ in diameter, mature in spring. Type locality, low points of the Saskatchewan near Carleton House (Drummond).

ILLUSTRATIONS:—Hampe & Schwaegr. l. c.; Sull. Icones Musc. Suppl. pl. 16; Pl. 32.

EXSICCATI:—Drumm. l. c.; Sull. & Lesq. Musc. Bor. Am. (Ed. 2) 234, in part; Holzinger, Musc. Acro. Bor. Am. 91; R. & C. Musc. Am., Sept. 46b.

On wet bare soil, Central and Plains region, north to Manitoba and Ontario, south to Kansas and Ohio; Utah (Garrett). The broad leaves, short seta and very large annulus make this one of the easiest species to recognize; often mixed with *P. turbinatum*.

6. *PHYSCOMITRIUM COLORADENSE* E. G. B. Bull. Torr. Bot. Club 21: 206. pl. 202. 1894.

Plants small, 3-4 mm. high, scattered or gregarious; stems 1-2 mm. high, mostly simple; leaves few, radical, concave, 1-2 mm. long, broadly ovate, "auriculate," short-acuminate, entire or serrulate above; costa comparatively slender, ending in or below the apex, basal cells more or less inflated. Calyptra lobed at base; *seta 1-2.5 mm. long, mostly much shorter than the perichaetial leaves*; capsule $\frac{2}{3}$ or more emergent, about 2 mm. long, mostly much longer than the seta, pyriform, becoming turbinate and contracted below the mouth when dry, light brown to orange, mouth bordered by 4-7 rows of transversely elongated cells and a *large double annulus of vesicular cells*; operculum large, conic-rostrate; spores warty, distinctly not spinose, 24-35 μ , maturing in spring. Type locality, Colorado (Brandege), April 13, 1877 (in herb. N. Y. Bot. Garden). Also collected in Montana (Williams) and Wyoming (Porter). *Pl.* 32.

Nearest to *P. Hookeri*, differing in the shorter seta, narrower annulus, and uniformly broader leaves. Indeed farther collections may prove that it is only a variety or form of *Hookeri*. Distinguished from

Pyramidula tetragona by the large size of the capsule compared to the plants, the lobate calyptra and double annulus.

Williams' plants might easily be referred to *Hookeri* as the setae are twice the length of the leaves.

7. *PHYSCOMITRIUM IMMERSUM* Sull., in Gray's Manual (Ed. 1) 648. 1848.

Physcomitrium sphaericum var. *insignis* Sull. Musc. Allegh. 196. 1848.

Closely resembling *Aphanorhagma serratum* and often confused with it; plants usually somewhat larger, reaching 8 mm.; leaves hardly to be distinguished; capsules immersed, nearly globose to pyriform-globose, reaching 0.9 mm. in diameter, strongly apiculate; operculum constituting about the upper $\frac{2}{5}$ of the capsule; seta very much shorter than the capsule; exothecial cells *irregularly quadrate to hexagonal, rather thick-walled*, two or three rows of smaller cells along the line of dehiscence, called annulus by some; calyptra narrowly mitrate-conic, 3-4-lobed at base, covering about $\frac{1}{4}$ the operculum but in total length much more than $\frac{1}{2}$ the capsule diameter; spores spinose, about 30 μ in diameter, mature in autumn.

Type locality, river banks, southern Ohio near Cincinnati (Lea). Type in Sullivant Herb. at Harvard.

ILLUSTRATIONS:—Sull. Icones Musc. pl. 56; Jennings, Mosses Western Pa. pl. 16; M. H. M. pl. 41.

EXSICCATI:—Sull. l. c.; Sull. & Lesq. Musc. Bor. Am. (Ed. 1) 155; (Ed. 2) 233; Aust. Musc. Appal. 179; Holzinger, Musc. Acro. Bor. Am. 242.

On damp soil, especially that covered at high water, often along river banks; Colorado and Minnesota to Quebec; south to Missouri and S. Carolina.

Infrequently collected, probably overlooked. Distinguished from *Aphanorhema serratum* as noted under that species; from *A. patens* by the thicker walls of the exothecial cells, the regular dehiscence above the equatorial line, the much longer apiculus of the capsule and the longer calyptra.

4. *ENTOSTHODON* Schwaegr. Suppl. 2¹: 44. 1823.

Intermediate between *Funaria* and *Physcomitrium*, having the parenchymatous leaf cells of the family, also the well developed costa; annual or reproducing by innovations. Monoicous; capsules erect and symmetric or nearly so, pyriform; operculum convex to conic-apiculate; mouth of capsule bordered by several rows of transversely elongated cells; annulus lacking; peristome single in our species, rarely lacking, sometimes with the merest rudiment of an inner peristome; calyptra inflated-cucullate, long-rostrate. Type species, *E. attenuatus*.

Differing but little from *Funaria* except in the erect and symmetric capsules and united with it by Brotherus and other recent authors.

The stem measurements *do not* include the leaves.

KEY.

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|---|----------------------------|
| 1. Leaves broadly acute to rounded-obtuse; capsules short-pyriform, erect, 1-1.4 mm. long. | 10. |
| Leaves sharply acute to acuminate; capsules longer. | 2. |
| 2. Exothecial cells irregular to hexagonal, little longer than broad. | 3. |
| Exothecial cells linear to oblong. | 4. |
| 3. Capsules erect and symmetric. | 9. <i>Leibergii</i> . |
| Capsules more or less unsymmetric and inclined. | 10. <i>neoscoticus</i> . |
| 4. Peristome rudimentary or lacking. | 5. |
| Peristome well developed. | 6. |
| 5. Costa often excurrent in the upper leaves. | 8. <i>rubiginosus</i> . |
| Costa ending below leaf apex. | 7. <i>Tucsoni</i> . |
| 6. Leaves nearly entire, bordered nearly to apex by at least two rows of narrow cells. | 1. <i>attenuatus</i> . |
| Leaves not as above. | 7. |
| 7. Leaves acute to short-acuminate. | 2. <i>Bartramii</i> . |
| Leaves (at least the upper) filiform-acuminate or apiculate. | 8. |
| 8. Capsules pyriform; operculum plano-convex. | 5. <i>plano-convexus</i> . |
| Capsules elongated-pyriform or clavate. | 9. |

- | | |
|---|-----------------------------|
| 9. Leaves nearly entire; capsules symmetric..... | 3. <i>Bolanderi</i> . |
| Leaves mostly serrate; capsules somewhat unsymmetric..... | 4. <i>rubisetus</i> . |
| 10. Costa stout, nearly percurrent..... | 6. <i>Drummondii</i> . |
| Costa thin, ending far below the apex..... | 11. <i>spathulifolius</i> . |

1. ENTOSTHODON ATTENUATUS (Dicks.) n. comb.

Bryum attenuatum Dicks. Pl. Crypt. fasc. 4: 8. pl. 19, f. 8. 1801.

Funaria Templetoni Sm. Engl. Bot. pl. 2524. 1813.

Entosthodon Templetoni Schwaegr. l. c. pl. 113.

Plants loosely to densely gregarious; stems 2-5 mm. long, with well developed central strand; lower leaves few, small and distant, the upper in a rosette, obovate to oblong-spatulate, when dry somewhat contorted, 2-3 mm. long, shortly acuminate to apiculate; margin bordered by about 2 rows of much narrower cells below, entire or crenate above by slightly projecting cell angles; costa ending well below the apex in the great majority of cases; upper leaf cells about 30 μ wide, 2-4:1, rectangular to oblong-hexagonal. Seta 5-10 mm. long, reddish; capsule elongate-pyriform, obconic and slightly contracted below the mouth when dry and empty; operculum plano-convex; peristome teeth reddish, linear from a short triangular base, inserted below the capsule mouth and nearly or quite in contact at the base, papillose, bent inwards when dry, easily broken; upper exothelial cells linear, incrassate with a very narrow lumen; spores 20-24 μ , mature in late spring. Type locality, European, probably British.

ILLUSTRATIONS:—Bry. Eur. pl. 302; Braithw. Brit. Moss Fl. 2: pl. 65C; Pl. 37.

California (Bolander, 2 collections); the teeth in Bolander's plants have an unmistakable median line. Sometimes the capsule may be slightly unsymmetric. A peculiar form from Oregon (Howell) in the herbarium of the N. Y. Botanical Garden has the costa strong and extending nearly to the leaf apex, which is often obtuse; the peristome teeth are strongly papillose.

2. ENTOSTHODON BARTRAMII n. sp.

Entosthodon Bolanderi of Holzinger's Musc. Acro. Bor. Am. no. 639. (not Lesq. 1869).

Plantae caespitosae; caulibus 2-4 mm. altis; folis in caule inferiore remotis, parvis; superioribus approximatis, oblongis vel obovatis, breviter acuminatis vel acutis, supra medium serratis cum cellulis brevibus, non linearibus; cellulis medio-superioribus 30 μ latis, 1.5-2:1; costa sub apice evanida; peristomium ut in *E. Bolanderi*; sporis 25 μ , laevibus.

Plant gregarious, apparently biennial or perennial by innovations; stems 2-4 mm. high; lower leaves distant and minute, upper clustered, oblong to obovate or spatulate, reaching 1.5 mm. in length, acute to very shortly acuminate, serrate above with short inflated marginal cells which are not narrower than the inner; upper median cells at end of costa \pm 30 μ in width, 1.5-2:1, cells below these becoming longer and rectangular toward the base; costa ending well below the apex, extending about $\frac{4}{5}$ the length of the leaf. Seta about 4 mm. long; capsule and peristome scarcely to be distinguished from that of *E. Bolanderi*; spores in early spring, about 25 μ in diameter, nearly smooth, Pl. 33.

Type, Holzinger's no. 639 from "Dry wash S. W. of San Xavier Mission, Pima Co., Arizona, alt. 2600 ft. (Bartram no. 1684, Feb. 23, 1927). Also near this locality nos. 1672 & 1682 and collected by Bartram in Tanque Verde Mts., Pima Co., Feb. 19, 1927; also Toros Canyon, Baboquivari Mts., Pima Co., March 27, 1827 (R. H. Peebles).

Bartram's 1682 is a very large form, stems reaching 1 cm. in height, leaves 3-4 mm. long, capsules 3 mm. long, spores slightly rough.

3. ENTOSTHODON BOLANDERI Lesq. Trans. Am. Phil. Soc. 13: 10. 1869.

Plants loosely gregarious, yellowish-green; stems short, 1-2 mm. high; leaves few, mostly clustered at top of stem, obovate to oblong-spatulate, mostly widest above the middle, slenderly acuminate, reaching a little more than 2 mm. in length, concave and flaccid, entire or sometimes slightly crenulate above by the protruding angles of the marginal cells, with the acumen usually terminated by a single long cell; costa rather weak, extending $\frac{1}{2}$ - $\frac{3}{4}$ the length of the leaf; leaf cells thin-walled and lax, more or less swollen especially near the base, the upper irregularly oblong-hexagonal, 30-45 μ wide, 1.5-3:1; basal rectangular to oblong,

much longer, narrower at the margin. Calyptra very long-beaked, lobed at base, longer than the capsule; seta slender, 7-15 mm. long, light red-brown; capsule elongate-pyriform, 2-2.5 mm. long, neck fully twice the length of the spore sac, gradually tapering into the seta; operculum highly convex-conic; sometimes mammillate; mouth of capsule bordered by 3-5 rows of incrassate transversely elongated, dark red cells, below these 3-4 rows of uncolored thinner-walled cells, short-rectangular to quadrate; upper exothecial cells below these oblong-linear, very thick-walled; peristome of 16 slender brittle teeth narrowly linear-lanceolate, with 8-10 articulations, reaching 0.36 mm. in length, coarsely granulose and less striate above than in *attenuatus*, ending (when unbroken) in a slender, almost smooth point, with median line very inconspicuous or lacking; spores finely granulose, about 30 μ in diameter, mature in early spring. Type locality, wet clay ground near San Francisco, California (Bolander). Type in the James Herbarium at Harvard.

ILLUSTRATIONS:—Sull. Icones Musc. Suppl. *pl.* 17; *Pl.* 35.

EXSICCATI:—Sull. & Lesq. Musc. Bor. Am. (Ed. 1) 236.

Several times collected in California by Bolander and others; San Clemente Id. (Mainz, no. 6636) and San Nicholas Id. (Howell); Port San Quentin, Lower California, Mexico (Palmer); apparently a coastal plant.

Occasionally the costa in the upper leaves reaches nearly to the base of the acumination while in the lower leaves it may be almost lacking. The plants of this genus in the southwestern U. S. have not been adequately collected and studied. There seems to be a great deal of variation depending on ecological factors. Bartram's 1680 from the Santa Catalina Mts., Arizona has been referred by Mr. Bartram and myself to a robust form of this species. Its leaves are broadly ovate, abruptly short-acuminate and somewhat serrulate; the inner peristome is moderately developed. It may well represent a distinct variety or even species. A plant of Bolander's in the herbarium of the U. S. National Museum has acute entire leaves about 1 mm. long; short-pyriform capsules and a double peristome. It may be a depauperate *E. Bartramii*.

4. ENTOSTHODON RUBRISSETUS (Bartram) n. comb.

Funaria rubriseta Bartram, Bryol. 31: 93. 1928. *pl.* 9. *figs.* A-F. (description quoted).

"Autoicous, male flower terminal on a short branch from near the base. Plants densely tufted, up to 8 or 10 mm. high, radiculose below, branched toward the base; upper stem leaves crowded, oblong-spatulate, about 3 mm. long, shriveled and contorted when dry, erect-spreading when moist, yellowish green, slightly concave, abruptly contracted to a rather short, straight, yellowish pellucid hair-point; margin entire below, bluntly serrate with projecting cells above the middle, often inflexed toward the apex; costa strong, brownish green, ending below the base of the acumen; leaf cells at base rectangular, four or five times as long as wide, above hexagonal-rhomboidal, not differentiated on the margin; seta red below, paler above, erect, flexuous, up to 12 mm. long; capsule 2-2.5 mm. high, asymmetrical, suberect or slightly curved, claviform, mouth slightly oblique, contracted under the mouth and tapering to a long, sulcate neck when dry; annulus none; peristome double, teeth dark red, vertically and obliquely papillose-striate, obliquely arranged and united at the apices by a disc, articulations 8-10, inconspicuously trabeculate, segments of the inner peristome shorter than the teeth or quite rudimentary and truncate, pale, papillose, indistinctly articulated; lid conical-convex; calyptra extending about half way down the capsule, 3 cleft at the base; spores nearly smooth, 20-22 μ in diameter."

"TYPE: Sycamore Canyon, Baboquivari Mts., Pima Co., Arizona, altitude about 5000 ft., March 20, 1927, E. B. Bartram, No. 1673."

"The serrate leaf margin and shorter hair-points clearly distinguish this species from *F. apiculato-pilosa* Card., from Mexico and the curved, asymmetrical capsules and piliform-pointed leaves preclude any confusion with *F. Bolanderi*. The capsules in this species vary considerably in both size and shape but they are never quite erect or quite symmetrical; a more or less pronounced swelling on one side gives them a slightly gibbous form that is rather characteristic." *Pl.* 34.

Type seen by courtesy of E. B. Bartram.

Stems alone about 2 mm. long; leaves but little over 2 mm. long; many setae only 6 mm. long; some capsules not noticeably unsymmetric after drying; *peristome teeth filiform, pale and papillose and not striate in the upper half*; inner peristome lacking or difficult of demonstration; operculum bordered by about 4 rows of transversely elongated cells, those above various and spirally arranged.

5. ENTOSTHODON PLANO-CONVEXA (Bartram) n. comb.

Funaria plano-convexa Bartram, Bryologist 31: 94. *pl.* 9. 1928.

"Autoicous, male flower terminal on a short branch from near the base. Plants densely tufted, yel-

lowish green, up to 7 mm. high, radiculose below, branched toward the base; upper stem leaves crowded, oblong-ovate or oblong-spatulate, about 2.5 mm. long, shrivelled and contorted when dry, erect-spreading when moist, slightly concave, abruptly contracted to a short, straight, piliform-acuminate point, margin entire below, bluntly serrate by projecting cells in the upper half; costa ending below the apex; leaf cells at base rectangular, up to three times as long as wide, median and upper cells hexagonal-rhomboidal, the marginal row often rather elongate toward the acumen but otherwise not differentiated; seta slender, reddish below, paler above, 6-8 mm. long, erect or slightly curved; capsule symmetrical, pyriform, about 2 mm. high, tapering to a short neck which is irregularly sulcate when dry; annulus none; lid plano-convex, the inner cells obscurely oblique, smaller and very dense at the center; peristome double, teeth about 225 μ long, reddish, vertically and obliquely papillose-striate below, paler and coarsely papillose at the apex, zigzag median line faint, articulations 7 or 8, faintly trabeculate, barely projecting on the margin, segments of the inner peristome very rudimentary, up to 25 μ high, slightly wider than the teeth, pale yellow, papillose, truncate, articulations 1 or 2, indistinct; calyptra split on one side, extending almost to the base of the capsule; spores faintly granulose, about 20 μ in diameter."

"TYPE: Sycamore Canyon, Baboquivari Mts., Pima Co., Arizona, altitude about 5000 ft., March 20, 1927, E. B. Bartram, No. 1678."

"The pyriform capsules, plano-convex lid and piliform-pointed leaves distinguish this species from *F. Bolanderi*." Pl. 34.

Stem alone about 2 cm. long; upper exothelial cells linear, lumen about equal to the thickness of the cell walls.

Leaves resembling those of *E. Bolanderi* but more abruptly acuminate or piliform and more serrate above; capsule less slender-necked with a relatively larger spore sac; operculum flattened-convex with no trace of apiculus; peristome teeth deeply inserted, shorter and more slender. Type seen from herb. E. B. Bartram. The inner peristome which Bartram mentions is either often absent or very difficult of demonstration. Neither have I been able to find it in *E. Bolanderi*, although Bartram puts it under "Peristome double" in his key (Bryol. l. c. 90).

6. ENTOSTHODON DRUMMONDII Sull. Mosses U. S. 51. pl. 4. 1856.

Entosthodon obtusifolius Hook. f. & Wils. in Drumm. Musc. Am. S. States 36. 1841, not of Hook. Icon. Pl. Rar. pl. 245A. 1841.

Plants loosely gregarious, yellowish-green; stems short, 1-4 mm. high, radiculose at base only, nearly naked below with leaves clustered and rosulate above, oblong to obovate-lanceolate, somewhat concave, entire or very slightly crenulate by the projecting angles of the row of somewhat elongated marginal cells, broadly acute to obtuse; upper cells oblong-hexagonal, 20-30 μ wide, 2-3 : 1, lower rectangular and longer; costa stout, almost percurrent. Calyptra long-rostrate; seta orange, turning darker with age, long and slender, 10-15 mm.; capsules short-pyriform, about 1.4 mm. long, erect and symmetric, oblong when dry and empty; operculum convex; upper exothelial cells with lumen about the width of the cell walls; peristome teeth linear-lanceolate, granulose, longitudinally striate above, dark red; annulus lacking; spores about 24 μ in diameter, warty, mature in early spring. Type locality, Louisiana (Drumm. l. c.).

ILLUSTRATIONS:—Sull. Icones Musc. pl. 55; Pl. 35.

EXSICCATI:—Drumm. l. c. (Type); Sull. & Lesq. Musc. Bor. Am. (Ed. 1) 156b, (Ed. 2) 235; Aust. Musc. Appal. Suppl. 506; Holzinger, Musc. Acro. Bor. Am. 219 (as var. *obtusifolia*); R. & C. Musc. Am. Sept. 47. On moist clay soil, Georgia, Alabama, Louisiana, Illinois (Holzinger). Apparently infrequent and local.

Leaves mostly more obtuse than figured by Sullivant.

7. ENTOSTHODON TUCSONI (Bartram) n. comb.

Funaria Tucsoni Bartram Bryol. 31: 91. pl. 8, figs. G-N. 1928.

"Autoicous, male flower terminal on a short branch from near the base. Plants densely tufted, yellowish green above, light brown below, up to 5 mm. high, radiculose below, branched toward the base; upper stem leaves crowded, oblong-ovate, about 2.75 mm. long, shriveled and contorted when dry, erect-spreading when moist, rather concave, short-acuminate; margin entire below, sinuose with slightly projecting cells or nearly entire above the middle; costa ending below the apex; leaf cells at base rectangular, about three times as long as wide, above hexagonal-rhomboidal, often elongate, not differentiated on the margin; seta pale brown below, yellowish above, erect or lightly curved, about 6 mm. long; capsule oblong;

pyriform, strongly contracted under the mouth when dry, tapering to a rather inflated, sulcate neck, erect, symmetrical, wide-mouthed, about 2 mm. high; annulus none; lid conical-convex when moist, plano-convex and mamillate when dry; peristome single, very rudimentary, teeth short, pale yellow, papillose, truncate or emarginate, often slightly perforate, articulations 1 to 3, indistinctly trabeculate; calyptra extending below the middle of the capsule, 3 to 5 cleft at the base, but not mitriform, more deeply split on one side and subcucullate; spores up to 40 μ in diameter, papillose." *Pl. 34.*

TYPE: along dry wash west of Picture Rocks, Tucson Mts., Pima Co., Arizona, altitude about 2500 ft., E. B. Bartram, No. 1679. March 2, 1927.

"This species seems to be near *F. Sonorae* Card. from northern Mexico but is perfectly distinct in the very rudimentary peristome, more sharply acuminate leaves and much larger spores."

Type seen by courtesy of E. B. Bartram.

On the 5 specimens mounted on a slide the largest leaves were about 2.5 mm. long, most about 2 mm., they were much more gradually acuminate than figured and the marginal cells were often short and swollen as in *E. Bartramii*; the opercula were conic-mamillate when moist and bordered by a band of specialized cells resembling annulus cells but firmly attached. This species differs from *E. Leibergii* in the longer oblong-pyriform capsule with incrassate exothelial cells and with upper cells of operculum not spirally arranged, less developed peristome and larger spores. On 4 of the operculate capsules studied the operculum came off easily but left no trace of peristome, the fifth had a peristome like that figured.

8. ENTOSTHODON RUBIGINOSUS (Williams) n. comb.

Funaria rubiginosa Williams, Bryol. 16: 37. *pl. 4.* 1913.

"Male flowers not found. Fertile plants growing in compact cushions with mostly simple stems 3-5 mm. high; the upper stem and perichaetial leaves broadly ovate or slightly obovate, about 2 mm. long, with nearly or quite entire margins and acute, short-subulate point; costa often excurrent into the point in the upper leaves, vanishing well below the apex in the smaller, lower ones; leaf cells lax, the median more or less rhomboidal to hexagonal, about 20 μ wide and up to 40 μ long, the marginal scarcely different; seta erect, 5 or 6 mm. long; capsule erect, about 2 mm. long, somewhat pyriform when dry, finally becoming reddish brown, with a furrowed neck scarcely as long as sporangium, containing about 3 rows of stomata; the cells about the rim of capsule transversely elongate in 4-6 rows, those farther down much elongate vertically, all with more or less thickened walls; peristome scarcely evident or sometimes of pale, slightly papillose, distant teeth of only 2 or 3 articulations each; annulus none; lid conic when moist, its height a little less than the basal diameter, the first 5 or 6 rows of lower cells transversely elongate, those above broadly oblong, in erect rows to the apex; spores rough, 25-28 μ in diameter; calyptra cucullate, long-beaked, more or less lacerate at base.

"Type locality; Missouri River banks just below Great Falls, Montana (June, 1887, No. 31, R. S. Williams)". Type in herb. N. Y. Botanical Garden. *Pl. 37.*

"This species seems to be most closely related to *F. Bolanderi*, but that has a well-developed outer peristome, the leaf-cells rather larger and more lax and the costa vanishing far below the apex of leaf."

9. ENTOSTHODON LEIBERGII E. G. Britton, Bryol. 3: 34. *pl. 1.* 1900.

Plants gregarious; stems 2-3 mm. long, simple or divided at base, naked below; leaves crowded at the summit, the largest 2-3 x 1 mm., oblong-lanceolate, acute or apiculate, entire to serrulate; costa ending below the apex to shortly excurrent; upper leaf cells oblong to hexagonal, about 30 μ wide, 1-2.5 : 1, marginal longer and narrower; lower elongated, rectangular, angular occasionally inflated, forming auricles. Autoicous; seta 5-10 mm. long, pale, becoming red-brown with age as does the capsule, which is globose-pyriform, 1-2 mm. long, with a tapering neck; the neck has numerous stomata and is wrinkled when dry; operculum convex, outer cells quadrate, colored, in straight rows, the central in oblique rows, irregular; mouth of capsule sometimes slightly flaring when dry and bordered by 4-8 rows of transversely elongated cells, cells below these irregularly quadrate to hexagonal, little longer than broad, only slightly thickened; annulus none; peristome short, rudimentary or lacking; teeth irregular, colored; spores 25-29 μ , rough.

Type locality, wet springy places near Hope, Idaho, alt. 2100 ft. May, 1892 (Leiberg). Collected again in the same locality in March 1893 and sent out as Musci Leibergiani 315, *Entosthodon fasciculare* (herb. U. S. Nat. Museum). The only known collections. The short exothelial walls are found in our species only in this and *E. neoscoticus*. *Pl. 36.*

Type in the herbarium of the N. Y. Botanical Garden.

10. ENTOSTHODON NEOSCOTICUS Margaret S. Brown, Bryol. 35: 17. f. 1. 1932.

Plants gregarious or scattered among other mosses; stems 1-2 mm. long, simple or divided at base; leaves crowded, forming a rosette at the summit, oblong-lanceolate to oblong-spatulate, about 2 mm. long, acute or apiculate; costa yellow, red when old, percurrent, or excurrent in a short point; margins entire, plane at apex, recurved towards the base; cells smallest at apex, all thin-walled, hexagonal, rhomboid, or quadrate, 15 μ wide, 1-2 : 1, becoming larger towards the base, reaching 3 : 1 and hyaline at insertion, border cells in the lower $\frac{2}{3}$ long and narrow. Autoicous; seta red, usually 4 mm. long, sometimes reaching 6 mm.; calyptra cucullate with only a single slit at base, narrow, not inflated; capsule elliptic-ovoid, 1-1.5 mm. long, erect and symmetric to inclined and slightly gibbous, with neck small, indistinct and wrinkled when dry, otherwise smooth; operculum rostellate, straight, mouth bordered by 2-4 rows of small dark colored cells; *exothecial cells thin-walled, short-rectangular to hexagonal; peristome fugacious or lacking*; spores 27-40 μ , rough. Type locality, Peggy's Cove, Halifax Co., Nova Scotia, Sept. 19, 1928 (Brown, no. 485); on damp gravelly soil and in crevices in granite rocks at sea level. Type in the herbarium of the N. Y. Botanical Garden; cotypes in herb. Miss Brown and A. J. G. Pl. 36.

Mrs. Britton wrote Miss Brown as follows: "I found a distinct annulus of two rows of brown cells, and what appears to be a pale dehiscent annulus inside. Mr. Williams and I have also seen fragments of what may be a rudimentary peristome in pieces, quite papillose, but lying near the annulus, as if it had grown there."

11. ENTOSTHODON SPATHULIFOLIUS Card. & Thér. Proc. Wash. Acad. Sci. 4: 312. pl. 17, figs. 1 a-i. 1902.

Polygamous, more or less densely cespitose, green above, brownish below; stems erect, 10-15 mm. high, somewhat branched with slender clavate branches below the perichaetium; leaves soft, when dry erect-appressed and contorted, somewhat spreading when moist; the lower minute, ovate; the upper larger, 1.5-2 x 1 mm., *oblong-spatulate, entire, obtuse or subapiculate*; margins plane, sometimes subrevolute towards the base; *costa thin, attenuate, vanishing at a variable distance below the apex*; areolation lax, basal cells subrectangular, 60-80 x 30 μ ; median and upper shorter, rectangular, quadrate or subhexagonal, 25-30 x 20 μ , 1-2 rows of the marginal yellowish, longer and narrower. Inflorescence terminal, sometimes dioicous, sometimes synoicous; seta pale yellow, 6-9 mm. long, flexuous; capsules pyriform, unsymmetric and inclined, with a distinct attenuate neck; operculum convex-mamillate; calyptra short, cucullate, little or not at all inflated; other details lacking. (Translated from the original description). Pl. 36.

From St. Paul Island (Trelease, 2067, 2074).

"A remarkable species, very distinct from all the *Entosthodon* of Europe and N. America by its polygamous inflorescence, its leaves shortly spatulate, obtuse or subapiculate and its calyptra hardly swelling. It is much to be regretted that the too immature capsules do not show the peristome, annulus and spores." Type duplicate from the N. Y. Botanical Garden seen.

I am inclined to think this is a *Tayloria*, as the rhizoids are papillose and the leaves splachnaceous. Other students better acquainted with the *Splachnaceae* fail to agree with me and the decision must be left until mature capsules are obtained.

5. FUNARIA [Schreb.] Hedwig, Sp. Musc. 172. 1801.

Plants gregarious to cespitose; stems little branched; lower leaves distant, small, the upper much larger and more or less clustered, suberect in a bud-like cluster, entire or serrate, acute to acuminate; costa well developed, ending below the apex to shortly excurrent; areolation lax, basal cells rectangular, upper rhombic to oblong-hexagonal, marginal often narrower. Autoicous; calyptra inflated-cucullate, long-rostrate, smooth; seta many times longer than the stem, often very strongly twisted when dry; capsules with a conspicuous neck, mostly elongated-pyriform, strongly unsymmetric to arcuate, rarely erect, smooth to strongly plicate, with mouth often oblique; annulus of large revoluble cells or lacking; peristome deeply inserted, double in our species; teeth 16, lanceolate-subulate, filiform at apex, somewhat spiraled to the right, usually reddish; *segments opposite the teeth* and nearly as long, or often rudimentary or lacking; operculum almost flat to convex. Type species, *F. hygrometrica*. Intergrading with *Entosthodon*, distinguished in most cases by the unsymmetric capsule and double peristome.

KEY.

- | | | |
|----------------------------------|--------------|----|
| 1. Annulus large, revoluble..... | (annulata) | 2. |
| Annulus lacking..... | (exannulata) | 8. |

2. Peristome segments less than $\frac{1}{2}$ the length of the teeth or rudimentary; spores 23–30 μ in diameter 3.
Peristome segments lanceolate, slender-pointed, at least $\frac{3}{4}$ the length of the teeth; spores 12–15 μ 5.
3. Capsule erect and symmetric or nearly so; arctic plants 4. *polaris*.^{*}
Capsules horizontal to pendent 4.
4. Capsules distinctly and strongly striate-costate; rare, northern 2. *microstoma*.
Capsules irregularly wrinkled; common in the southeastern U. S. 3. *flavicans*.
5. Capsules horizontal to pendent; turgid 6.
Capsules suberect to horizontal, more slender 7.
6. Capsules short-pyriform; spores 18–24 μ 1c. var. *utahensis*.
Capsules elongated pyriform; spores 14–17 μ 1. *hygrometrica*.
7. Perichaetial leaves broad and convolute-clasping; western 1b. var. *convoluta*.
Perichaetial leaves not convolute-clasping, southern 1d. var. *calvescens*.
8. Costa excurrent 9.
Costa ending below apex 10.
9. Leaves entire; costa shortly excurrent; segments nearly as long as the teeth 5. *americana*.
Leaves serrulate; costa long-excurrent; segments rudimentary, about $\frac{1}{4}$ length of the teeth 6. *Orcutti*.
10. Leaves entire; capsules mostly erect and symmetric 9. *californica*.
Leaves entire or serrulate; capsules unsymmetric and inclined 11.
11. Leaves long-acuminate, serrate or entire 7. *calcareo*.
Leaves acute to very shortly acuminate, serrate 8. *serrata*.

Annulata.

Annulus present, of 2–3 rows of large vesicular cells becoming detached in curled segments; margin of operculum margined by a row of somewhat similar persistent cells; upper exothelial cells irregular and nearly as broad as long or oblong and 2–3 : 1.

1. FUNARIA HYGROMETRICA [L.] Hedw. l. c.

Plants rather loosely gregarious, light green; stems 3–10 mm. high, erect, simple or branching at base; lower leaves small, the upper rather closely imbricated into a bulb-like tuft at first, later more distant and looser, somewhat contorted when dry, oblong-ovate to obovate, concave, the upper often subtubulose above, 2–4 mm. long, acute to shortly acuminate, entire or the upper slightly serrulate above; costa stout, ending just below the apex to very shortly excurrent; leaf cells more or less inflated, the upper subhexagonal, about 30 μ wide, 1–2 : 1, lower more elongated, narrower at the margins. Calyptra inflated-cucullate, rostrate; seta 2–5 cm. long, strongly twisted; capsule subpyriform, horizontal to pendent, \pm 3 mm. long, very unsymmetric and arcuate, deeply sulcate when dry, at first greenish-yellow becoming dark brown with age, with a very oblique mouth which is often almost parallel to the capsule axis; operculum slightly convex, 0.7–1 mm. wide; exothelial cells on the dorsal side elongated and in alternating rows of broader and narrower cells; those on the ventral side shorter, almost as broad as long; peristome teeth spirally twisted, strongly papillose and dark red with faint vertical striae below, above subhyaline, strongly trabeculate and appendiculate with ciliate-fimbriate appendiculae, united by their tips to a small lace-like central disk; segments papillose, lanceolate, slender-tipped, somewhat shorter than the teeth; spores small, 14–17 μ , very smooth, mature spring to summer. Type locality, European.

ILLUSTRATIONS:—Bry. Eur. pl. 305; Jennings, Mosses W. Pa. pl. 17; M. H. M. f. 97; Mosses with a Hand-lens, pl. 41 & figs. 51, 52, and others; Pl. 38.

EXSICCATI:—Sull. & Lesq. Musc. Bor. Am. (Ed. 1) 159, (Ed. 2); Aust. Musc. Appal. 181 & 182; Holz. Musc. Acro. Bor. Am. 67; Grout, Musci Perfecti 38.

Cosmopolitan, found nearly everywhere in locations at all suitable for vegetation. Waste places and bare soil, especially where fires have burned.

* Neither plants of *F. polaris* Bryhn nor description have been available. See appendix.

Forma LONGINERVIS n. f.

Costa valde excurrens in foliis superioribus; capsulae minime latae.

Costa decidedly excurrent in the upper leaves as in *F. flavicans*; capsule rather narrower, otherwise as in the typical form. Type from cypress swamp, Dayton, Florida, S. C. Hood, May 19, 1911, in herb. A. J. G.; also from Lake Helen, Florida, offered to the Sullivant Moss Society by B. D. Gilbert as *F. flavicans* in the July 1904 Bryologist; Lafayette, Louisiana (Bro. Neon no. 296); Virginia (Fisher). Usually mistaken for *F. flavicans* because of its excurrent costa, but the long slender segments of the inner peristome readily distinguish it.

ia. Var. PATULA Bry. Eur. l. c. fig. β . 1841.

Plants tall and slender, loosely foliate, often branched below, leaves more distant, longer and narrower, more contorted when dry; costa more often excurrent; seta long and strikingly yellow when first mature. Pl. 38.

EXSICCATI:—Sull. & Lesq. Musc. Bor. Am. (Ed. 1) 160; Aust. Musc. Appal. Suppl. 508 (as var. *calvescens*); Holz. Musc. Acro. Bor. Am. 93; Grout, Musci Perfecti 80.

Mostly in the southeastern U. S., where it is not rare. It is to *hygrometrica* what *Physcomitrium Längloisii* is to *P. turbinatum*.

ib. Var. CONVOLUTA Hampe, Linnaea, 1859-1860: 455.

A western variation; upper leaves broadly obovate-spatulate, mostly with a strongly incurved margin, subtubulose, the inner more or less convolute around the seta and sometimes serrulate above; costa mostly percurrent or excurrent; capsules narrower, less curved and rarely at all pendent, sometimes horizontal; segments almost as long as the teeth, from a well developed basal membrane, tapering evenly from the base to the slender apex; peristome teeth less papillose and conspicuously striate below. Type from the Sierra Nevada, California.

Frequent on the Pacific slope from California to Washington.

The type needs to be seen to make sure just what Hampe had in mind but the study of a considerable number of forms shows numerous intergradations with typical forms and the differences in any case are slight. The figures of *hygrometrica* in the Bry. Eur. show the leaves somewhat convolute around the seta and such is the case in all young plants with sporophyte just appearing.

A specimen from near Banda, Colombia, S. America, Dec. 1898 (Baker) was named by Kindberg *F. pseudohygrometrica*. This was probably never published.

ic. Var. UTAHENSIS n. var.

A *F. hygrometrica* differt, costa percurrente vel excurrente, capsula brevior.

Leaves little different from *F. hygrometrica*, with costa percurrent to shortly excurrent. Annulus present, large; capsule short-pyriform, inclined to pendent; peristome much like that of *hygrometrica*, but teeth densely papillose with fine elongate papillae; spores 18-24 μ , smooth, mature in spring. This variety has the capsule and spores of *F. flavicans* (except the smoothness of the latter) and the peristome of *hygrometrica* (except for a slight difference in markings).

Type, "Plants of Utah and Nevada from the Rocky Mt. Herbarium of the Univ. of Wyoming, no. 1002, among thick grass, Modena, Utah, June 2, 1902 (Gooding)." Also no. 8699 of the same series from Centennial, Albany Co., Wyoming, July 27, 1902 (Aven Nelson) det. by Holzinger as *F. flavicans*. Another collection from the same series (Gooding 2029) from French Creek, Carbon Co., Wyoming, Aug. 28, 1903, was determined as *F. convoluta* by Holzinger. All three of these specimens are in the herbarium of the U. S. National Museum at Washington, Univ. of Wyoming, and of A. J. G.

id. Var. CALVESCENS (Schwaegr.) Bry. Eur. l. c. fig. γ .

Funaria calvescens Schwaegr. Suppl. 12: 77. pl. 65. 1816.

Leaves as a rule more elongated, more narrowly oblong-lanceolate and more often subtubulose; costa more often excurrent; capsules more slender, merely inclined; less arcuate, usually widest at the mouth when dry; sporophyte (including spores) otherwise little different except that the teeth on the average have the

striae a little more apparent. Extreme forms seem quite distinct and this variety seems to be very common south of the U. S. and into S. America. Intergradations seem frequent and there are much the same variations in size and habit as in the species. *Pl.* 38.

More frequent in the southern U. S. and extending across the continent.

EXSICCATI:—Holz. Musc. Acro. Bor. Am. 481; Grout, Musci Perfecti, 81. Sull. Musc. Allegh. 125 appears to be the species.

1e. Var. ARCTICA Berggr. K. Sv. Vet-Akad. Handl. 137: 57. 1874.

Funaria arctica Kindb. Eur. & N. Am. Bryin. 330. 1897.

Type specimens small; stems 1–2 mm. long; leaves badly decayed. Seta 7–10 mm. long, strongly curved; capsules old, wrinkled, shaped like those of var. *calvescens* but smaller; segments of inner peristome nearly as long as teeth. Portions of the type from northern Greenland (1870, Berggren) were sent me by Dr. Hj. Möller. He also sent me specimens from "Jenesei, Siberia, Aug. 17, 1876" that are in perfect condition. These are perfect miniatures of *F. hygrometrica* except that the spores are 18–20 μ in diameter and the leaves rather more broadly ovate and obtuse; the costa is percurrent or nearly so. Williams plants (Bryol. 5: 70) are evidently not this variety as the inner peristome is rudimentary. (See *F. microstoma* var. *obtusifolia*.)

2. FUNARIA MICROSTOMA Bry. Eur. fasc. 11. *pl.* 306. 1841.

Strongly resembling small forms of *F. hygrometrica*; upper leaves more slenderly acuminate; costa ending in the slender apex; capsule about 2 mm. long, obovoid strongly unsymmetric, inclined to horizontal; operculum small, about 0.5 mm. in diameter, conic; peristome teeth more slender, scarcely appendiculate except in the upper hyaline portion; inner peristome a low membrane, more or less adherent to the teeth, typically with short projections opposite the teeth; spores about 25 μ , minutely roughened; mature in July and August. Type locality, European.

ILLUSTRATIONS:—Bry. Eur. 1. c.; Husnot, Musc. Gall. *pl.* 159; Braithw. Brit. Moss. Fl. 2: *pl.* 65E; *Pl.* 40.

"Moist gravelly ground; Soda springs on the Upper Tuolumne, California (Bolander); Illinois (Patterson, Schneek)." L. & J. Manual 203.

Bolander's specimens have been examined, they closely match the European in spite of the fact that Brotherus and Paris do not credit *microstoma* to N. America.

Forma CANADENSIS n. f.

Folia minus tenui-acuminata; capsula 3 mm. longa in collo longiore, operculo 0.6–0.7 mm. in diam.

Leaves less slenderly acuminate; capsule with longer neck, about 3 mm. long; operculum 0.6–0.7 mm. in diameter. Type from Limestone barrens, Cape Norman, Newfoundland, Aug. 13, 1925 (Bayard Long, no. 328).

2a. Var. OBTUSIFOLIA n. var.

Folia late acuta vel obtusa; costa percurrente.

Stems 2–5 mm. long; leaves broadly acute to obtuse; costa nearly or quite percurrent; capsules obovoid, turgid, about 1.6 mm. long, mouth less oblique; inner peristome a more or less divided membrane, mostly attached to the inner face of the teeth; spores up to 24 μ . Type from mouth of Bonanza creek, near Dawson, April 1, 1899 (Williams). Type in herb. A. J. G. (comm. Williams) and N. Y. Bot. Garden. Also collected near the same spot July 13, 1902 (no. 148 in the Canadian National Museum).

3. FUNARIA FLAVICANS Mx. Fl. Bor. Am. 2: 203. 1803.

Similar in appearance to *F. hygrometrica* and often growing with it.

Leaves obovate, entire, the upper slenderly acuminate by the excurrent costa; capsules usually shorter, with a shorter neck, less unsymmetric, globose-pyriform, less furrowed, with mouth less oblique and usually smaller; operculum about 0.6 mm. in diameter; peristome teeth more slender, scarcely appendiculate except at the hyaline apex, papillose-striate; segments of inner peristome short, less than $\frac{1}{2}$ the length of the teeth, blunt;

spores 20-25 μ in diameter, finely roughened when mature, maturing a week or two earlier than in *hygrometrica*. Type locality, eastern U. S.

ILLUSTRATIONS:—Sull. Icones Musc. pl. 53; M. H. M. f. 98; Bryol. 32: pl. 6; Pl. 40.

EXSICCATI:—Sull. & Lesq. Musc. Bor. Am. (Ed. 1) 158, (Ed. 2) 240; Aust. Musc. Appal. 183; Holz. Musc. Acro. Bor. Am. 92; Grout, Musci Perfecti, 208.

On much the same substrata as the last, but more southern in range; Connecticut to Indiana, west to the Mississippi, Oklahoma (Sharp),* south to the Gulf of Mexico. Common in the southern part of its range.

The L. & J. Manual says the capsule mouth in *flavicans* is larger than that of *hygrometrica*. My observations agree with those of Williams (Bryol. 4: 10. 1901) that it is smaller. In Musci Perfecti 208 the capsules have a longer neck than usual and appear much like those of *hygrometrica*.

Exannulata.

Annulus lacking; upper exothelial cells linear and strongly incrassate, the lumen often little wider than the thickness of the cell walls.

5. FUNARIA AMERICANA Lindb. Öfv. af K. Sv. Vet.-Akad. Foerh. 20: 398. 1863.

Funaria Muhlenbergii Hedw. f. (name only); Schwaegr. Suppl. 1²: 78. pl. 66. 1816 (invalid because of the use of the name by Turner for *F. calcarea* in 1805).

Plants gregarious, small; stems 4-8 mm. long; leaves clustered at the top of the stems, suberect, oblong-ovate to oblong-lanceolate, gradually acuminate, entire or nearly so, blade 2-2.3 mm. long and hair point rarely over 0.4 mm.; *costa strongly excurrent into this hair point*; upper leaf cells oblong to oblong-hexagonal, about 24 μ wide, 2-3 : 1, marginal slightly or not at all narrower; basal elongated, rectangular. Seta 6-10 mm. long; capsule oblong-pyriform, unsymmetric and inclined, 2 mm. or less in length including the neck, which is nearly as long as the spore sac; spore sac usually somewhat shrunken but little wrinkled when dry and empty, neck wrinkled; operculum conic, apparently falling with the calyptra; mouth of capsule bordered by 5-6 rows of incrassate, transversely elongated colored cells, below these a few irregular uncolored cells; the remaining exothelial cells of the spore sac linear, with walls as thick as the width of the lumen or even thicker; peristome double, the teeth red-brown, somewhat trabeculate, appendiculate, of 10-12 or more articulations, faintly papillose and striate, often with faint zigzag median line; *segments nearly or quite as long as the teeth, somewhat papillose*; spores 20-28 μ , finely roughened, mature in spring. Type locality, Pennsylvania (Muhlenberg).

ILLUSTRATIONS:—Sull. Icones Musc. Suppl. pl. 19; M. H. M. f. 99; Bryologist 5: pl. 2.

EXSICCATI:—Drum. Musc. Am. 236 (as *F. Muhlenbergii*); R. & C. Musc. Am. Sept. 374; Holzinger, Musc. Acro. Bor. Am. 112.

On bare soil and among grasses; Pennsylvania, Minnesota, Ohio, Texas, Georgia; rare, but locally abundant. Bartram, Bryologist 31: 90, says it is known from California.

The capsules are more contracted under the mouth when dry than is shown in Sullivant's plate. The dry capsules of the Pennsylvania and Minnesota plants strongly resemble those of an *Amblystegium* but the Texas plants collected by Orcutt have the spore sac more inflated and the fallen calyptras contain the operculum and quantities of spores.

6. FUNARIA ORCUTTI Bartram, Bryologist, 31: 90. pl. 8, figs. A-F. 1928.

Plants densely tufted, containing plants with last season's capsules and others with immature capsules of date of collection; stems up to 4-5 mm. high, branched at base; leaves yellowish green, erect, shriveled when dry, spreading when moist, the upper crowded, concave, about 2 mm. long, broadly ovate to obovate, *abruptly contracted to a flexuous piliiform point 0.6-1 mm. long, hyaline at the tip; margin entire below, sinuate or bluntly serrate with projecting cells toward the apex; costa usually long-excurrent into a nearly smooth flexuous hair-point*, or rarely ending below apex in the lower leaves; leaf cells at base lax, rectangular, above hexagonal-oblong, hardly different at the margin. Autoicous, male flower terminal on a short branch from near the base; seta reddish, 3-5 mm. long; capsule unsymmetric, slightly arcuate to nearly erect, gibbous at back, 1.5-2 mm. long, with a long sulcate neck nearly as long as spore sac, mouth oblique; peristome

* Sharp's plants from Oklahoma are rather immature and have spores smooth, about 18 μ in diameter. They are small with seta about 1 cm. long while some from Ocala, Florida, have a bright yellow seta about 5 cm. long.

double, teeth reddish, linear-lanceolate, inserted below the mouth and projecting about 0.15 mm. above the rim, vertically and obliquely papillose-striate nearly to the pale papillose tip, articulations about 6, hardly appendiculate, lightly trabeculate; segments of inner peristome pale, truncate, about $\frac{1}{4}$ the length of the teeth; operculum conic, the cells not in spiral or oblique rows; calyptra deeply split on one side, reaching nearly to capsule base; spores nearly smooth, up to 30 μ in diameter. Type from Fort Davis, Jeff Davis Co., Texas, alt. about 520 ft. May 22, 1926 (C. R. Orcutt, no. 7112). Type seen, from herb. E. B. Bartram; description adapted from the original. *Pl.* 34.

Distinguished from all the *exannulata* except *F. americana* by the excurrent costa, from this it is distinct by the much longer excurrent costa and generally serrate leaves, the much less prominently trabeculate peristome teeth and rudimentary inner segments.

7. FUNARIA MUHLENBERGHII Turn. in Konig Sims Ann. Bot. 2: 198. 1805 (not of Hedw. f., which is a *nomen nudum*).

Funaria calcarea Wahlenb. Sv. Vet.-Akad. Handl. 27: 137. *pl.* 4. f. 2. 1806.

Funaria dentata Crome, Samml. deutscher Laubm. 2. Nachl. no. 12 c. diagn. 1806.

Funaria hibernica Hook. in Curtis Fl. Lond. (Ed. 2) 378. 1817.

Funaria mediterranea Lindb. in Oefv. af K. Sv. Vet.-Akad. Foerh. 20: 399. 1863.

Laxly caespitose, leafless stems 2-4 mm. high; upper leaves clustered, oblong-lanceolate to oblong-obovate, 1.5-3 mm. long, rather abruptly to gradually narrowed to a slender filiform acumination 0.2-0.6 mm. long, entire to serrate above; costa ending well below the apex; leaf cells oblong-hexagonal to rectangular, little different below, narrower at the lower margins. Seta erect, reddish, 4-15 mm. long; capsules 2-3 mm. long, pyriform, unsymmetric, inclined, with neck nearly as long as the spore sac and wrinkled when dry; spore sac only slightly shriveled and contracted under the mouth when dry; operculum convex conic; 5-7 rows of colored and transversely elongated cells below capsule mouth, below these about 2 rows of irregular uncolored cells, then linear incrassate exothelial cells; peristome double, deeply inserted, teeth red brown except at apex, of 10-15 articulations, strongly trabeculate and appendiculate, papillose-striate, linear lanceolate, reaching 60-90 μ in width at base; segments narrowly lanceolate, about $\frac{2}{3}$ the length of the teeth, papillose; spores 20-30 μ , rough, mature in early spring. Type locality, European.

ILLUSTRATIONS:—Bry. Eur. *pl.* 303 & 304; Braithw. Brit. Moss Fl. *pl.* 65D; Husnot, Musc. Gall. *pl.* 58 & 59; *Pl.* 27 & 40.

EXSICCATI:—Bartram, Mosses of Southern Arizona, 117, 759; Drumm. Musc. Am. 236.

Bare soil, apparently preferring alkalinity, up to 2500 ft., Arizona, California, Utah, Yukon (Williams).

The synonymy of this species constitutes a puzzle of the first order. For details see Braithwaite and Limpricht.

I am in hearty accord with Braithwaite and Dixon in uniting *F. calcarea* and *F. mediterranea*. The leaves of most American plants are nearly entire but Bartram's plants from near Tucson, Arizona, have very markedly serrate leaves; however serration of leaves is quite variable and does not seem correlated with any other character.

7a. Var. PATULA Bry. Eur. fasc. 11. *pl.* 303. β .

Var. *occidentalis* R. & C. Bot. Gaz. 15: 43. 1890.

Leaves entire, shortly and abruptly apiculate, in American specimens broadly obovate. Howe, Musci Californici no. 75 (as *F. Muhlenbergii*), roadsides near Olema, Marin Co., March 31, 1894. Also a few plants were found in Sull. & Lesq. Musc. Bor. Am. (Ed. 2) 238 in the herbarium of the U. S. National Museum. The main part of 238 is the typical form of *F. californica*.

7b. Var. LINEATA n. var.

Cellula exothecii oblonga vel oblonga-hexagona, non incrassata; peristomii dentibus linearibus, 30-45 μ latitudine, ad longitudinem striatis et papillosis, processibus brevioribus dentibus interdum adherentibus.

Leaves not to be distinguished from the type, either entire or serrate; exothelial cells oblong to oblong-hexagonal, not incrassate; peristome teeth narrow, almost linear, 30-45 μ wide at base, faintly papillose and strongly longitudinally striate, with outer plates often open between the articulations, not at all appendiculate; segments shorter and narrower, often somewhat adherent to the teeth; spores rarely over 20 μ , nearly smooth. Type, Holzinger, Musc. Acro. Bor. Am. 640, from Sycamore Canyon, Baboquivari

Mts., Pima Co., Arizona (Bartram no. 1677). Also Bartram's Mosses of Southern Arizona no. 991, from steep shaded banks of dry washes in Tucson Mts., Pima Co. and in shelter of rocks on N. side of hill near Palm Springs, California, March 22, 1922 (H. G. McKeever no. 4). Drummond's 236 approaches var. *lineata*.

8. FUNARIA SERRATA Brid. Musc. Recent. Suppl. 4: 124. 1819.

Plants annual or biennial, gregarious; stems 2-6 mm. high; lower leaves small and distant, upper clustered, contorted when dry, elliptic- to oblong-lanceolate, 2-3 mm. long, *broadly acute to short-acuminate, serrate above by projecting cells; costa ending below apex*; upper leaf cells oblong-hexagonal, 25-30 μ wide, 1-2 : 1, marginal longer and narrower; lower leaf cells elongated, mostly rectangular; seta 1-2 cm. long, slender; capsules pyriform, unsymmetric and arcuate, slightly wrinkled when dry, more so at the neck, operculum mammillate; mouth of capsule bordered by 6-8 rows of incrassate transversely elongated cells; upper exothelial cells linear, *very thick-walled, walls as thick as width of lumen*; peristome double, teeth red-brown, scarcely appendiculate, faintly papillose and striate; *segments nearly or quite as long as the teeth*, papillose, with a distinct median line; spores about 24 μ in diameter, rough, mature in spring. Type locality, southern U. S.

ILLUSTRATIONS:—Sull. Icones Musc. *pl. 54; Pl. 39.*

EXSICCATI:—Drumm. Musc. Am. S. States 76; Sull. Musc. Allegh. 126; Sull. & Lesq. Musc. Bor. Am. (Ed. 1) 157, (Ed. 2) 239; Aust. Musc. Appal. Suppl. 507; R. & C. Musc. Am. Sept. 48; Grout, Musci Perfecti 206.

Moist unoccupied soil, especially clay in banks and fields. Southern states, Georgia to Texas and Oklahoma.

Most of the leaves observed are less slender at apex than figured by Sullivan. The linear extremely incrassate exothelial cell walls around the spore sac are very characteristic of the exannulata and explain the slight wrinkling of the capsule as compared with the annulata.

9. FUNARIA CALIFORNICA Sull. & Lesq. Musc. Bor. Am. (Ed. 2) 238. 1865.

Plants *very small*, rather scattered; stems (exclusive of leaves) about 1 mm. long; upper leaves clustered, contorted to crispate when dry, oblong to oblong-ovate, *about 1 mm. long, entire, concave, with plane margins, broadly acute*, rarely apiculate with a single cell; costa strong, ending just below the apex; lower and marginal cells rectangular, 15-20 μ wide, 1-2 : 1, upper median hexagonal to oblong. Seta 4-6 mm. long; *capsule erect and symmetric or very slightly unsymmetric*, pyriform, 1-2 mm. long, with neck nearly as long as spore sac, little wrinkled when dry except at the neck; operculum convex-conic; upper exothelial cells linear, incrassate, mouth of capsule bordered by 8-10 rows of transversely elongated cells; peristome double; teeth slender, papillose, *of 6-7 articulations; segments well developed*, shorter than the teeth, papillose; spores 15-18 μ , rough, mature in spring. Type locality, California (Bolander). In the set of Sull. & Lesq. 1. c. in the U. S. National Museum there are a few plants of *F. calcarea* var. *patula*; these can be distinguished by their curved capsules.

ILLUSTRATIONS:—Sull. Icones Musc. Suppl. *pl. 18; Pl. 39.*

On bare clay soil, California; Oregon, Hall (according to the Lesq. & James Manual). Rare and local but beautifully distinct. It is the smallest of the true Funarias. It is most likely to be confused with the Entosthodonts but its small leaves and well developed double peristome will place it easily in most cases.

SPLACHNACEAE.*

BY GENEVA SAYRE.

Plants rare in our region, mostly caespitose, green above and brown with papillose radicles below, lax, with large, loosely areolate leaves; stems usually short, in some species reaching 8 cm., with true and false leaf traces; leaves lingulate and obtuse to broadly obovate and long-acuminate, or narrowly lanceolate,

* This, with monographs of the *Aulacomniaceae* and *Timmiaaceae*, presented in partial fulfillment of the requirements for the degree of Master of Arts, University of Wyoming. Contributions from the Botany Department and Rocky Mountain Herbarium, University of Wyoming, No. 153.

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costa ending immediately below the apex, sometimes forming the greater part of the acumination, in cross section containing at the middle a number of "comites," usually thick-walled and angular, and a few larger "intercalary" cells,† the whole surrounded by large, thin-walled sheath cells; in the axils of many of the leaves are small brown structures, "corpuscles" of Schimper, "club-hairs" of Brotherus and Limpricht, sometimes mistaken for antheridia but having the structure of paraphyses, with a large club-shaped end-cell and several small stalk-cells. Autoicous or dioicous, rarely synoicous, male flower subdiscoid, terminal on a special stem or at the ends of branches, or sessile along the stem by reason of innovations, antheridia and paraphyses numerous; perigonal leaves squarrose from orange, concave sheaths that form the cup; perichaetial leaves large, not differing in structure from stem leaves. Seta from 1 to 20 cm. long; hypophysis present in all but two genera (*Voitia* and *Splachnobryum*), ranging from a mere neck to a conspicuous object, bizarre in form and color, composed largely of loose assimilative tissue, at first green, with numerous stomata, especially in the upper part; capsule erect and symmetric, cylindric or globose, brown or red; calyptra various; columella exerted or included, with a flat-topped disc at the summit; peristome of a single row of 32 divisions, often of 3 layers, in all except one species (*Tayloria splachnoides*) permanently joined together to form 16 teeth (so-called for convenience in the following keys and descriptions) which may be partially joined in twos and fours, finely papillose, composed of two or three layers of cells, in one species (*Tayloria lingulata*) a preperistome, in two genera (*Voitia* and *Oedipodium*) peristome absent.

Growing mostly at high altitudes in damp forests of the north, but one species (*Tetraplodon pennsylvanicus*) in swamps along the Atlantic coast to Florida. On plant and animal remains, dung, decaying carcasses and the like, and apparently confined to them at least for the founding of a colony. Certain species (notably in *Tetraplodon*) exude an odor of carrion attractive to flies, which probably aids in spore dissemination, and it is likely that the bright colored hypophysis in *Splachnum* also attracts insects; some even exude a secretion attractive to insects. That the hypophysis is a part of the seta rather than of the capsule seems a logical conclusion (see Goebel *Organography* 2: 159. 1905).

KEY TO THE GENERA.

- | | | |
|--|--|---------------------------|
| 1. Hypophysis absent..... | subfamilies <i>Voitiaeae</i> and <i>Splachnobryeae</i> . | 6. |
| Hypophysis present, peristome present (excl. <i>Oedipodium</i>), operculum differentiated | | |
| | subfamily <i>Splachneae</i> . | 2. |
| 2. Peristome absent; leaf margins ciliate at the base..... | | 3. <i>Oedipodium</i> . |
| Peristome present; leaf margins not ciliate at the base..... | | 3. |
| 3. Calyptra constricted at the base; hypophysis narrower than the capsule and colored the same; peristome teeth erect or reflexed..... | | 4. <i>Tayloria</i> . |
| Calyptra not constricted below; hypophysis usually wider than the capsule and of a different color; peristome teeth usually reflexed..... | | 4. |
| 4. Peristome teeth truncate, in pairs, then single..... | | 5. <i>Haplodon</i> . |
| Peristome teeth acuminate, in fours and pairs..... | | 5. |
| 5. Teeth in fours, of two layers of tissue, inserted far below the mouth; hypophysis lighter colored than the capsule (excl. <i>T. pennsylvanicus</i>)..... | | 6. <i>Tetraplodon</i> . |
| Teeth usually in pairs, of three layers, inserted at the mouth; hypophysis darker than the capsule (excl. <i>S. luteum</i>)..... | | 7. <i>Splachnum</i> . |
| 6. Capsule cleistocarpous..... | | 1. <i>Voitia</i> . |
| Capsule with operculum and peristome..... | | 2. <i>Splachnobryum</i> . |

LEAF KEY TO THE SPECIES.*

- | | |
|---|-------------------------------------|
| 1. Leaves narrowly lanceolate..... | 2. |
| Leaves obovate or lingulate..... | 3. |
| 2. In swamps along the Atlantic coast to Florida..... | <i>Tetraplodon pennsylvanicus</i> . |
| At higher elevations, southern Canada and northern United States..... | <i>Tetraplodon angustatus</i> . |

† The names are those of Lorenz *Flora*, 1867.

* This key is presented, not as an infallible guide to sterile specimens, but in the hope that it may be of some assistance. The family is a variable one in gametophyte characters, and much of the descriptions both here and following must be considered approximate as regards size and leaf serration.

- | | | |
|---|-----|----------------------------------|
| 3. Leaves blunt, lingulate..... | 4. | |
| Leaves acute or acuminate or apiculate, or when blunt obovate..... | 7. | |
| 4. Leaves clustered at the tops of stem and branches..... | 5. | |
| Leaves \pm uniform down the stem..... | 6. | |
| 5. Leaves ciliate at the base..... | | <i>Oedipodium Griffithianum.</i> |
| Leaves not ciliate..... | | <i>Tayloria Hornschuchii.</i> |
| 6. All leaves entire..... | | <i>Tayloria Froelichiana.</i> |
| Some leaves dentate..... | | <i>Tayloria lingulata.</i> |
| 7. Leaves entire or nearly so..... | 8. | |
| Leaves toothed..... | 15. | |
| 8. Leaves blunt or acute..... | 9. | |
| Leaves long-acuminate..... | 11. | |
| 9. Leaves obovate-lingulate, leaf bases ciliate on the margin..... | | <i>Oedipodium Griffithianum.</i> |
| Leaves broadly ovate or obovate, bases not ciliate..... | 10. | |
| 10. Upper leaf cells mostly rectangular, 25 x 35 μ | | <i>Splachnobryum Bernoullii.</i> |
| Upper leaf cells mostly diamond-shaped, 40 x 90 μ | | <i>Splachnum vasculosum.</i> |
| 11. Acumination yellow; upper leaf cells thicker-walled than those at the middle of the leaf..... | | <i>Tetraplodon urceolatus.</i> |
| Acumination not yellow; walls of upper leaf cells not different from the rest..... | 12. | |
| 12. Leaves concave..... | 13. | |
| Leaves not concave..... | 14. | |
| 13. Leaf margins plane..... | | <i>Tetraplodon mnioides.</i> |
| Leaf margins somewhat incurved..... | | <i>Voitia nivalis.</i> |
| 14. Cells rectangular..... | | <i>Haplodon Wormskioldii.</i> |
| Cells diamond-shaped or hexagonal..... | | <i>Splachnum ovatum.</i> |
| 15. Leaves toothed nearly to the base..... | | <i>Splachnum rubrum.</i> |
| Leaves toothed only in the upper part..... | 16. | |
| 16. Leaf teeth large, of several cells..... | | <i>Splachnum ampullaceum.</i> |
| Leaf teeth small, of a single cell..... | 17. | |
| 17. Some leaves entire..... | | <i>Splachnum ovatum.</i> |
| All leaves toothed..... | 18. | |
| 18. Leaves long-acuminate..... | | <i>Tayloria serrata.</i> |
| Leaves short-acuminate or acute, or blunt and apiculate..... | | <i>Tayloria splachnoides.</i> |

Subfamily VOITIEAE.

1. VOITIA Hornsch. Comment. de Voitia et Systilio. 5. pl. 1. 1818.

One species:

VOITIA NIVALIS Hornsch. op. cit.

Voitia hyperborea Grev. et Arn. Act. Soc. Wern. 4: 109. pl. 7. 1825.

Plants 3-6 cm. high, yellow-green, densely radiculose below the upper 5 mm.; leaves somewhat crisped, elongate-ovate, abruptly long-acuminate, acumen composed mostly of the costa, concave, entire, reaching 1.5 x 5 mm., margins somewhat incurved; upper leaf cells rectangular, 20-25 x 35-55 μ , lower cells 55-95 μ long, margin cells long, yellow. Autoicous, male flowers at the ends of branches, subdiscoid, paraphyses numerous; seta 1-2 cm. long, yellowish to dark red, darkest in the upper part, straight or slightly twisted below, usually strongly twisted immediately below the capsule; hypophysis absent; capsule cleistocarpous, dark red, elongate-ovoid, erect and symmetric or slightly curved, 3 mm. long, broader at the base, drawn out to an oblique point above, about 1 mm. long, yellowish; calyptra cucullate at the tip, constricted at the base, sometimes not split below, often sliding down the seta; operculum not differentiated; spores 7-11 μ , smooth, released by a rupture of the capsule wall; mature in autumn.

Type locality, Carinthian Alps, Austria.

ILLUSTRATIONS:—Bry. Eur. *pl.* 7; Schwaegr. Suppl. 2^o: *pl.* 126; Broth. in Engler and Prantl (Ed. 1) Musci 1: *fig.* 353; *Pl.* 43.

EXSICCATI:—No American specimens have been seen. The above description is drawn from European material in the U. S. National Herbarium.

Especially on sheep droppings and peaty soil in arctic regions and high mountains. Reported from Greenland, Grant Land, Island of Melville.

The American material has been called *V. hyperborea*, and differs from true *V. nivalis* only in being smaller and the capsule more nearly ovoid. It is to be regarded merely as a smaller form of the European species (c. f. Bry. Eur. and Roth, Die aussereur. Laubm. 1: 221. 1911).

Subfamily SPLACHNOBRYEAE.

2. SPLACHNOBRYUM C. Muell. in Verh. z. b. Ges. Wien 593. 1869.

Didymodontis sp.? Hook. Musc. Exot. *pl.* 126. 1820.

Weisia sp. Brid. Bryol. Univ. 1: 358. 1826.

Syrhophodontis sp. Schwaegr. Suppl. 2^o: *pl.* 182. 1826-27.

Dissodontis sp. C. Muell. Syn. 1: 140. 1849.

Weisia (*Tapeinodon*) Mitt. Musc. Austr. Amer. 141. 1869.

Amblyphyllum Lindb. in Grevillea 1: 29. 1872.

Plants gregarious, slender, 1.5-5 cm. high, stems unbranched or loosely branched, with papillose radicles below; leaves usually distant, sparingly chlorophyllose, decurrent, lanceolate to orbicular, acuminate to cucullate at the apex, margins often reflexed below, usually entire, in one species slightly crenulate; costa ending below the apex; leaf cells large, lax, smooth. Dioicous, male heads terminal, without paraphyses; seta under 1 cm. long, twisted; *hypophysis absent*; capsule cylindric, 0.5 x 1-2 mm., red at the mouth; calyptra shorter than the capsule; operculum apiculate, usually red; columella included; annulus absent; peristome inserted below the mouth, teeth linear-lanceolate, papillose, cleft nearly to the base.

Mostly in the tropics and subtropics, on earth and rocks, one species in the water. In our range only:

SPLACHNOBRYUM BERNOULLII C. Muell. l. c. 505. 1869.

Plants loosely tufted, 3 or 4 cm. high, green, branched, stems often red, central strand faint; *leaves ± crisped when dry, rather distant, ovate-orbicular, concave, somewhat cucullate above, long-decurrent, 1-1.5 x 1.5-2 mm., sparingly chlorophyllose, without club-hairs but often with a group of radicles in the axils; costa stout, ending a few cells below the apex, intercalary cells not different from the comites; upper leaf cells mostly rectangular, 25 x 35 μ, lower elongate, about 25 x 75 μ. Pl. 43.*

EXSICCATI:—Holz. Musc. Acro. Bor. Am. et Eur. 598 (Bartram 1446a); Bartram Mosses of So. Ariz. 145.

The systematic position of this genus is uncertain. It does have undoubted affinities with the *Splachnaceae* through the *Voiteae*.

Subfamily SPLACHNEAE.

3. OEDIPODIUM Schwaegr. Suppl. 2^o: 15. *pl.* 105. 1823.

One species:

OEDIPODIUM GRIFFITHIANUM (Dicks.) Schwaegr. op. cit.

Bryum Griffithianum Dicks. Crypt. Fasc. 4: 8. 1801.

Plants low, small, under 5 mm., not or scarcely tufted; *leaves crowded at the top of the stem, sparingly chlorophyllose; upper leaves ovate to obovate-spatulate, 1 x 2-2.5 mm., rounded at the apex, entire, with long ciliate projections from the marginal cells at the base; costa stout, as broad as the leaf at the base, ending abruptly 6 or 8 cells below the apex; upper marginal cells quadrate, with the outer wall thinner than the other three; upper blade cells rounded or isodiametric, about 30 μ, lower elongate, 30 x 60 μ; usually with green, globose, many-celled, short-stalked gemmae in the axils of the leaves. Synoicous or autoicous; seta 3 mm. to 1 cm. long, straw-colored or hyaline; hypophysis about 3 mm. long, much narrower than the capsule and lighter-colored; capsule ovoid, about 1.5 mm. long, brown, exothecial cells transversely elongated in the upper 3 rows, then isodiametric to the hypophysis; operculum obtusely apiculate; columella included; *peristome absent*; spores papillose, about 30 μ, June, July and August.*

ILLUSTRATIONS:—Broth. Laubm. Fenn. fig. 40; Dixon and James. Handb. Brit. Mosses (Ed. 3) pl. 34F; Lotsy, Botan. Stammes. 2: figs. 198–199; Braithw. Brit. Moss Fl. 2: pl. 63; Pl. 42.

EXSICCATI:—No American specimens have been seen; the above description is based on nine packets of British *Oedipodium* in the U. S. National Herbarium.

Reported from Greenland and Alaska.

Braithwaite, l. c. 120, says "The pale succulent peduncle resembles much more that of a *Jungermania* than that of a moss."

4. TAYLORIA Hook. Jour. of Sci. and Arts. 2: 144. 1816.

Splachnum [L.] Hedw. Stirp. Crypt. 2: 35. 1792; Sp. Musc. 51. 1801 (in part).

Weissia Schwaegr. Suppl. 12: 63. 1811.

Hookeria Schleich. Catal. 1815.

Systylium Hornsch. Comment. de Voitia et Systylio. 19. 1818.

Eremodon Nees and Hornsch. Bryol. Germ. 22: 176. 1823.

Dissodon Grev. and Arn. Dispos. Meth. 13. 1825.

Plants 1–6 cm. high, often densely tufted; leaves various, lingulate and almost entire to pointed and serrate. Autoicous, dioicous or synoicous. Seta 1–4 cm.; *hypophysis narrower than the capsule and usually colored the same*, when dry wrinkled and forming a tapering neck; capsule globose or elongate-globose, often contracted below the mouth when dry and mature; *calyptra short, constricted at the base*; operculum conic or hemispheric and apiculate, in one species not deciduous; columella included or exserted; *teeth erect or reflexed*, in pairs or singly or split, *of two layers of cells, inserted at or below the mouth of the capsule*; spores papillose, large (to 45 μ) or small (to 15 μ), maturing in summer.

Type species, *T. splachnoides*.

On various substrata, mostly that impregnated with animal material; arctic North America, Canada and northern United States.

KEY.

- | | |
|--|-------------------------------|
| 1. Peristome teeth at maturity in pairs..... | 2. |
| Peristome teeth at maturity single or split into 32 segments..... | 6. |
| 2. Leaves obtuse, mostly entire; peristome teeth erect..... | 3. |
| Leaves acute or acuminate, toothed; peristome teeth reflexed..... | 4. |
| 3. Operculum not deciduous, remaining attached to the exserted columella; leaves clustered at the tips of stem and branches..... | 1. <i>Hornschuchii</i> . |
| Operculum deciduous, columella included; leaves \pm uniform down the stem.... | 2. <i>Froelichiana</i> . |
| 4. Leaves acute..... | 5a. var. <i>tenuis</i> . |
| Leaves acuminate..... | 5. |
| 5. Plants with long slender branches, reaching 6 cm.; leaves about 5 x 1 mm..... | 5b. var. <i>flagellaris</i> . |
| Plants reaching 3 cm.; leaves about 3 x 1 mm..... | 5. <i>serrata</i> . |
| 6. Peristome teeth 16, preperistome present; some leaves entire..... | 3. <i>lingulata</i> . |
| Peristome teeth split into 32, preperistome absent; leaves serrate..... | 7. |
| 7. Leaves blunt with a short tip, more coarsely serrate..... | 4. <i>splachnoides</i> . |
| Leaves acuminate..... | 4a. var. <i>acuminata</i> . |

Subgenus 1. DISSODON Grev. and Arn. op. cit.

1. TAYLORIA HORNSCHUCHII (Grev. and Arn.) Broth. Engler and Prantl (Ed. 1) Musc. 2: 502. 1909.

Systylium splachnoides Hornsch. Comment. de Voitia et Systylio. 19. pl. 2. 1818.*

Dissodon Hornschuchii Grev. and Arn. Dispos. Meth. 13. 1825.

Plants in low; dense tufts about 1 cm. high, usually mixed with other mosses, pale green above, brown below; *leaves crowded at the top of stems and innovations*, imbricated, *lingulate and obtuse*, somewhat keeled, *entire*, about 2 mm. long and 0.7 mm. wide, margins plane or slightly revolute in the lower part, lower leaves smaller; costa often brown, ending 3 or 4 cells below the apex, no intercalary cells; cells above the costa \pm

* Antedated by *Hookeria* [*Tayloria*] *splachnoides* Schleich. 1815.

quadrate, in the upper $\frac{1}{3}$ of the leaf rectangular (about $40 \times 20 \mu$), lower cells longer, marginal yellowish. Autoicous; *seta* stout, straw-colored, *not or scarcely twisted*, usually under 1 cm.; hypophysis about 1.5 mm. long, slender and tapering, never as wide as the capsule, straw-colored; capsule about 1 mm. long and 1 mm. wide, globose, not contracted below the mouth, pale, becoming red; exothelial cells very thick-walled, quadrate at the middle of the capsule; calyptra constricted at the base, about 2 mm. long; *operculum remaining attached to the exerted columella*, flat and with an obtuse, usually long apiculus; *peristome* orange-red, *erect*, inserted at the mouth, the 16 teeth partially split into 32, *truncate or obtuse*, densely papillose; spores $30-45 \mu$, papillose, brown, in August and September.

Type locality, Carinthian Alps, Austria.

ILLUSTRATIONS:—Bry. Eur. *pl.* 281; Limpr. Laubm. 2: *fig.* 253. *Pl.* 42.

EXSICCATI:—Drumm. Musc. Am. 46 (as *Systylium splachnoides*).

On soil and humus, summits of mountains; Oregon, Colorado.

2. TAYLORIA FROELICHIANA (Hedw.) Lindb. Musc. Scand. 19. 1879.

Splachnum Froelichianum [L.] Hedw. Stirp. Crypt. 3: 99. *pl.* 40. 1792; Sp. Musc. 50. 1801.

Splachnum punctatum Brid. Musc. Rec. Suppl. 1: 149. 1806.

Dissodon Froelichianus Grev. and Arn. Dispos. Meth. 13. 1825.

Plants about 1-3 cm. high, usually mixed with other mosses, branched; *leaves* dense, imbricated, yellow-green, slightly keeled, *lingulate*, *entire*, *obtuse*, sometimes with a small apiculus, about 2×1 mm., margins plane or slightly revolute below the middle; lower leaves smaller and somewhat invested with radicles; costa stout, scarcely narrowed above, ending 2 or 3 cells below the apex, intercalary cells absent or present on the ventral side; leaf cells large, upper mostly rectangular, $56-74 \times 15-37 \mu$, lower elongate, $75-110 \times 15-30 \mu$. Autoicous or dioicous, antheridia and archegonia about 0.2 mm.; *seta* twisted, stout, about 1 cm. long, dark orange; hypophysis and capsule slender, each about 1 mm. long; capsule when old consisting of a wide reddish mouth and a constriction from which the hypophysis tapers to the seta, hypophysis usually lighter colored than the capsule, when young the same color; operculum flat to conic, often with a blunt oblique tip; *teeth* yellow, in pairs, *erect to slightly reflexed when dry*; columella included; exothelial cells transversely elongate to about $\frac{1}{2}$ or $\frac{1}{3}$ down the capsule, then hexagonal or quadrate to the hypophysis, which has rectangular to elongate cells and numerous large stomata; spores large, $34-48 \mu$, coarsely papillose, brown, in mid-summer.

Type locality, Austria.

ILLUSTRATIONS:—Bry. Eur. *pl.* 282; *Pl.* 42.

EXSICCATI:—Drumm. Musc. Am. 44 (as *Splachnum Froelichianum*) and 45 (as *S. Froelichianum* var. *elongata*); Canadian Musci 379; Macoun, Canadian Musci 41 and 65 (the last three as *Dissodon*).

On damp earth and snow patches at high altitudes; British Columbia, Columbia Valley, Rocky Mountains.

3. TAYLORIA LINGULATA (Dicks.) Lindb. Musc. Scand. 19. 1879.

Splachnum lingulatum Dicks. Pl. Crypt. fasc. 4: 4. *pl.* 10, *f.* 6. 1801.

Weissia splachnoides Schwaegr. Suppl. 1: 63. *pl.* 17. 1811.

Dissodon splachnoides Grev. and Arn. Mem. Wern. Soc. 5: 468. *pl.* 15. 1825.

Eremodon splachnoides Brid. Bry. Univ. 1: 334. 1826.

Weissia turbinata Drumm. Musc. Am. 64. 1828.

Plants somewhat tufted, 3-5 cm. high, branched, green in the upper part; leaves mostly numerous, erect or somewhat imbricated, upper leaves larger, $1 \times 2-3$ mm., those below 0.5×1.5 mm., covered with radicles, all *leaves lingulate*, slightly keeled, *blunt to somewhat acute*, margins plane or revolute below, *almost entire or with irregular teeth near the apex* consisting of protruding cells; costa ending 4 or 5 cells below the apex, intercalary cells when present ventral; leaf cells large, those above $25-35 \times 45-100 \mu$, those below $30-40 \times 75-115 \mu$. Synoicous or dioicous, antheridia about 0.4 mm., archegonia reaching 0.8 mm.; *seta* 3-4 cm. long, yellowish, *twisted*, *weak*; hypophysis tapering when wet and dry, colored as the capsule or slightly darker; capsule usually broadly cup-shaped when dry, not contracted below the mouth, globose when wet, brown at maturity; calyptra constricted below; operculum almost flat to conic, apiculate to ob-

liquely beaked; columella included; peristome *teeth* yellow, *erect* when dry, *not united in pairs*, acuminate, inserted at the mouth, *preperistome present*; spores light brown, papillose, 25–40 μ , in July and August.

Type locality, Salzburg, Austria.

ILLUSTRATIONS:—Bry. Eur. *pl.* 283; Dixon and James. Handb. Brit. Mosses (Ed. 3) *pl.* 35E; Schwaegr. Suppl. 1: *pl.* 17; Braithw. Brit. Moss Fl. 2: *pl.* 62 (as *D. splachnoides*); *Pl.* 42.

EXSICCATI:—Drumm. Musc. Am. 64; Holz. Musc. Acro. Bor. Am. et Eur. 623; Canadian Musci, Geol. Surv., 381.

On damp earth at high elevations; Gaspé, British Columbia, Rocky Mountains.

One specimen (Macoun, Can. Musci 42) has the capsule barrel- instead of cup-shaped.

Subgenus 2. EUTAYLORIA Lindb. Musc. Scand. 19. 1879.

4. TAYLORIA SPLACHNOIDES (Schleich.) Hook. Jour. Sci. and Arts 2: 144. 1816.

Hookeria splachnoides Schleich. Catal. 1815.

Tayloria obliqua Sendt. ms in Rabenh. D. Kryptfl. 2^a: 92. 1848 (as synonym).

Plants 1–2.5 cm. high, clear green above, innovations sometimes flagellate; *leaves slightly crisped, lingulate to obovate, blunt or apiculate, strongly serrate above the middle*, keeled, 0.7–1 x 3 mm., with margins reflexed in the lower half; costa ending 4 or 5 cells below the apex, intercalary cells not different from the comites; leaf cells in the upper $\frac{1}{2}$ rectangular, about 40 x 70 μ , in the lower part elongate, about 50 x 120 μ . Synoicous or autoicous, heads terminal or axillary by innovations, antheridia and archegonia 0.2 mm. long; *seta* 1.5–3 cm. high, *slightly twisted*, yellow, becoming red with age; hypophysis long, to 3 mm., much more slender than the capsule, colored as the capsule or somewhat lighter; *capsule before maturity elongate-ovoid*, about 2 mm. long, green to yellow, *when ripe shorter*, cylindric and *contracted very suddenly to the hypophysis*, red, sometimes inclined; transverse walls of the exothecial cells thicker than the longitudinal walls; calyptra constricted below, about 1 mm. long; *operculum very long*, about 1 mm., conic and acuminate; columella usually included, sometimes exserted; *peristome split into 32 filaments*, each about 0.6 mm. long and 30 μ wide, *when dry inrolled outside the rim of the capsule*, when wet rolled inside the rim, inserted below the mouth, red, papillose; spores 11–15 μ , papillose, August and September.

Type locality, Switzerland.

ILLUSTRATIONS:—Bry. Eur. *pl.* 286; *Pl.* 41.

EXSICCATI:—Drumm. Musc. Am. 47; J. A. Allen, 23; Macoun, Chilliwack Lake, B. C., July 9, 1901.

On earth, rocks and the upturned roots of trees, at high elevations; Rocky Mountains, British Columbia, Gaspé.

The Drummond specimen is a slender form with the operculum as long as the capsule, and some of the leaves approach those of:

4a. var. ACUMINATA (Schleich.) Hueben. Muscol. Germ. 96. 1833.

Hookeria acuminata Schleich. in litt.

Tayloria acuminata Hornsch. in Fl. 8: 78. 1826.

Tayloria splachnoides var. *cuspidata* C. Muell. Syn. 1: 136. 1848.

Tayloria splachnoides var. *mucronata* Hartm. Skand. Fl. (Ed. 5) 358. 1849.

Tayloria splachnoides var. *angustifolia* Schimp. Syn. (Ed. 1) 301. 1860.

Plants usually shorter, about 1 cm. high; *leaves short-acuminate or acute*, more weakly serrate in the upper $\frac{1}{2}$, upper cells diamond shaped, about 30 x 45 μ , lower elongate, 30 x 75 μ . Sporophyte as in the species, except operculum sometimes obtuse.

EXSICCATI:—Macoun, Canadian Musci 97, Devil's Lake, Canadian Rockies.

According to Brotherus and Limpricht this variety has brood bodies arising from the stem tomentum.

5. TAYLORIA SERRATA (Hedw.) Bry. Eur. fasc. 23–24. 1844.

Splachnum serratum Hedw. Sp. Musc. 53. *pl.* 8. 1801.

Splachnum tenue De Not. Epil. 463. 1869.

Plants 1–3 cm. high, scarcely tufted, sparingly branched; *leaves* clear green, distant or crowded, erect, somewhat crisped, larger in the upper part of the stem, *acuminate, obovate* and tapering gradually below,

serrate in the upper half, marginal cells slightly yellowish; upper leaves about 1 x 3 mm., lower shorter; costa strong, ending in or just below the acumen, cells in cross section large, round intercalary, enclosing a group of small angular comites, or intercalary cells ventral; upper leaf cells diamond-shaped or rectangular, 20–30 x 30–60 μ , lower cells elongate and lax, 30–60 x 60–110 μ . Autoicous or dioicous; antheridia 0.3 mm. long; *seta* 1–3 cm. long, dark, *twisted, thick*; hypophysis 1 mm. long, when dry much shrunken, when wet almost as wide as the capsule and continuous with it; capsule 2 mm. long and 1 mm. wide, smoothly cylindric, dark, blackish in old specimens; calyptra short, constricted below, mitrate to cucullate; operculum hemispheric, apiculate, yellow; *columella often exserted*; *teeth red*, in pairs or separate, when dry and mature *reflexed to the capsule wall or erect*; spores almost smooth, round, yellow, small, 10–12 μ , maturing in May and June.

Type locality, Schneeberg, Austria.

ILLUSTRATIONS:—Bry. Eur. *pl.* 284; Limpr. Laubm. 2: *fig.* 254. *Pl.* 41.

EXSICCATI:—Holz. Musc. Acro. Bor. Am. 162 (in part), 215 and 423; Allen, Mosses of Casc. Mts. 49; Canadian Musci, Geol. Surv., 382; Howell Pac. Coast Pl. (Alaska) 1827; McFadden, Bryoph. of Canada 636; Macoun, Canadian Musc. 34; Macoun, Prince of Wales Isl. (Alaska), Sept. 29, 1891 and Piers Farm, Victoria, Vancouver Isl., May 11, 1893.

On the dung of domestic animals, earth, rocks and rotten wood. Alaska, Newfoundland, Behring Sea Region, British Columbia, Vancouver Isl.; Washington, Oregon, California, Vermont.

5a. var. *TENUIS* (Sm.) Bry. Eur. fasc. 23–24. 1844.

Splachnum tenue Sm. Fl. Brit. 1171. 1804.

Grimmia splachnoides Sw. in Sm. Fl. Brit. 3: 1197. 1805.

Splachnum attenuatum Brid. Sp. Musc. 1: 146. 1806.

Splachnum longicollum Dicks. Pl. Crypt. fasc. 4: *pl.* 10, *fig.* 9. 1802.

Tayloria tenuis Schimp. Syn. (Ed. 2) 360. 1876.

Tayloria parvula Philib. and Aman in Rev. Bryol. 16: 56. 1889.

Upper leaves shorter and broader than in the species, about 1 x 2 mm., *acute* or sometimes slightly apiculate. *Seta* characteristically more slender and under 2 mm. long; capsule shorter; spores sometimes larger. Grading into the species. By Brotherus and Limpricht distinguished from the species by the presence of brood-bodies.

Type locality, Harz Mountains, Germany.

ILLUSTRATIONS:—Bry. Eur. *pl.* 285; Dixon and James. Handb. Brit. Mosses (Ed. 3) *pl.* 35D; Braithw. Brit. Moss Fl. 2: *pl.* 62C.

EXSICCATI:—Grout, Musci Perf. 77 (as *T. serrata*); Canadian Musci, Geol. Surv., 383; Macoun, Canadian Musci 75; Macoun, Victoria, June 6, 1908 and May 8, 1893.

"On substances less impregnated with animal remains than the species" (Schimper). Greenland, Cape Breton, British Columbia, Vancouver Island.

5b. var. *FLAGELLARIS* (Brid.) Bry. Eur. fasc. 23–24. 1844.

Splachnum flagellare Brid. Musc. Rec. Suppl. 1: 145. 1806.

Splachnum helveticum Schleich. Catal. 1807.

Splachnum tenue var. *flagellare* Roehl. Deutch. Fl. 3: 43. 1813.

Plants to 6 cm. high, freely branched, *branches long*, sometimes reaching to the capsule, *with distant leaves*; leaves *longer and narrower*, those above 1 x 5 mm., margins revolute in the lower $\frac{3}{4}$.

ILLUSTRATIONS:—Bry. Eur. *pl.* 285.

EXSICCATI:—Macoun, Bonanza Creek, Aug. 20, 1902.

On animal dung, Greenland, Yukon Territory.

5. HAPLODON R. Brown Vermischte Botan. Schriften. 1: 442. 1826 (as *Aplodon*).

Splachnum Hornem. Fl. Dan. 10²⁸: 8. *pl.* 1659. 1819.

Eremodon Brid. Bry. Univ. 1: 237. 1826.

Tetraplodon Lindb. Musc. Scand. 19. 1879.

Plants delicate, 2–6 cm. high, branched, *leaves erect* to somewhat imbricated or slightly crisped, *ovate to obovate-lanceolate, acute to acuminate, entire or nearly so*; costa ending 6–8 cells below the apex. Autoicous;

sporophyte slender, *seta* weak; hypophysis longer than the capsule and occasionally wider; calyptra short, mitrate; *teeth* at first in pairs, then separate, truncate, reflexed or erect, of two layers.

One species:

HAPLODON WORMSKIOLDII (Hornem.) R. Brown op. cit.

Splachnum Wormskioldii Hornem. op. cit.

Eremodon Wormskioldii Brid. op. cit.

Tetraplodon Wormskioldii Lindb. op. cit.

Plants light green above, often with flagellate branches; leaves 1 x 2 mm. to 1.5 x 3 mm., acuminate or occasionally acute, flat to keeled, mostly entire; costa sometimes forked above; intercalary cells not different from the comites or intercalary cells ventral; leaf cells rectangular, upper 20 x 50-90 μ , lower about 20 x 90 μ , marginal longer and usually yellow, cell at the apex rounded or flat on the upper side. Male inflorescence on axillary branches, antheridia 0.4 mm.; seta 1-2 cm. long, almost hyaline, twisted, flexuous; hypophysis colored as the capsule or somewhat lighter, at maturity wrinkled, when wet constricted above and below; capsule and hypophysis 0.5 x 1.5 to 1 x 2 mm., becoming black with age; capsule ovate when wet, widest at the mouth when dry, reddish, brightest above, exothecial cells transversely elongated to quadrate-rectangular and very sinuose-walled; operculum hemispheric and sometimes apiculate; columella included; spores 10-15 μ , smooth, yellow-green, in June and July.

Type locality, Greenland. Arctic North America to the Behring Sea.

ILLUSTRATIONS:—Bry. Eur. pl. 291; Schwaegr. Suppl. 21: pl. 108 (both as *Splachnum*); Dixon and James. Handb. Brit. Mosses (Ed. 3) pl. 35B (as *Tetraplodon*); Pl. 42.

EXSICCATI:—Holz. Musc. Acro. Bor. Am. 422 (Sweden); Hb. of the Sulliv. Moss Soc. 3,958 (Canadian Arctic Exp.); Pl. of Can. Arc. Exp. (1913-1916) 17c, 26, 31; Macoun, Can. Musci, St. George Island, July 15, 1892.

6. TETRAPLODON Bry. Eur. fasc. 23-24. 1844.

Splachnum Hedw. Stirp. Crypt. 2: 35. 1792. Sp. Musc. 51. 1801 (in part).

Bryum Brid. Musc. Rec. 4: 36. 1803.

Plants usually in dense tufts, mostly 3 cm. high or less, reaching 8 cm.; leaves slenderly lanceolate, or obovate and acuminate, or blunt and subcochleariform, toothed or entire. Autoicous or rarely dioicous, male flowers terminal or axillary; seta reaching 5 cm. but usually about 1 cm., often shorter; hypophysis various, from slightly narrower to wider than the capsule, and almost the same color, wrinkled when dry; capsule cylindric to ovoid, reddish; calyptra short, cucullate, *not constricted below*; columella usually included, occasionally exserted; *peristome teeth reflexed*, orange, *composed of two layers of cells, at some time in fours*, separating into twos; spores small, smooth or slightly papillose.

Type species, *T. angustatus*. There have been retained in this genus all the species whose teeth are two-layered and are at some time in fours.

On earth and animal material. Greenland, Alaska, Labrador, Newfoundland, west to Vancouver Island, in the northern part of the United States, south along the Atlantic coast.

It has been repeatedly shown that species of *Tetraplodon* exude an odor of carrion attractive to flies; the theory is that the stomata in the hypophysis give off a sticky exudation that causes the odor (see Bequaert, Bryologist 24: 1. 1921 and Erlanson, Bryologist 33: 13. 1930).

KEY.

- | | |
|---|----------------------------|
| 1. Leaves entire or nearly so, ovate or obovate-lanceolate..... | 2. |
| Leaves with large teeth, long-lanceolate..... | 3. |
| 2. Seta 1-5 cm. long; leaves somewhat crisped, costa forming the greater part of the acumination..... | 1. <i>mnoides</i> . |
| Seta under 1 cm.; leaves \pm imbricated, costa ending at the base of the acumination, upper leaf cells thicker-walled than those at the middle..... | 2. <i>urceolatus</i> . |
| 3. Hypophysis lighter colored than the capsule, calyptra reaching to the hypophysis; at higher elevations, southern Canada and northern U. S..... | 3. <i>angustatus</i> . |
| Hypophysis darker than the capsule, calyptra barely covering the operculum; in swamps along the Atlantic coast to Florida..... | 4. <i>pennsylvanicus</i> . |

I. TETRAPLODON MNIOIDES (Hedw.) Bry. Eur. fasc. 23-24. 1844.

Splachnum mnioides [Linn. f.] Hedw. Sp. Musc. 51. 1801.

Splachnum urceolatum var. *minus* Wahl. Bot. Arr. (Ed. 3) 794. 1812.

Splachnum urceolatum var. *mnioides* Sw. Summa Veg. Scand. 38. 1814.

Splachnum arcticum, *propinquum*, *exsertum* R. Brown, Fl. Isl. Melville. 301. 1824.

Tetraplodon bryoides [Zoega] Lindb. Musc. Scand. 19. 1879.

Plants densely tufted, 2-8 cm. high, light green above; leaves dense, erect, somewhat crisped, obovate-lanceolate, 1 x 3 to 2 x 5 mm., concave, entire, with a long flexuous point, sometimes as long as $\frac{1}{3}$ of the leaf, of which the costa forms the greater part; cells of the costa in cross section showing comites surrounded by intercalary cells, or intercalary cells not different from the comites; leaf cells mostly rectangular above, about 20 x 35 μ , those below elongate, about 35 x 110 μ , marginal cells sometimes longer and yellow. Autoicous, male heads terminal or axillary, antheridia and archegonia 0.4 mm.; seta straw-colored, later red, varying in length from 1 to 5 cm., stout, not twisted; capsule with hypophysis 2-4 mm. long; hypophysis usually wider and longer than the capsule, lighter colored when young and colored the same when mature, large stomata often over the whole surface; capsule reddish, becoming almost black with age, in mature dry specimens contracted below the mouth, somewhat inclined when young; exothecial cells of the middle of the capsule quadrate to hexagonal, thick-walled, of the hypophysis rectangular to elongate; calyptra long and narrow, cucullate; operculum hemispheric, usually apiculate, becoming red with the capsule; columella included; teeth reflexed, in fours then pairs, dark orange, red at the tips; spores smooth or slightly papillose, 7-11 μ , June, July and August.

Type locality, Austria.

ILLUSTRATIONS:—Bry. Eur. pl. 289 (also M. H. M. pl. 40); Dixon and James. Handb. Brit. Mosses (Ed. 3) pl. 35A; Braithw. Brit. Moss; Fl. 2: pl. 62A.

EXSICCATI:—Drumm. Musc. Am. 40 (as *Splachnum*); Grout Musci Perf. 187 (as *T. bryoides*); Sull. and Lesq. Musc. Bor. Am. (Ed. 1) 152b; Holz. Musc. Acro. Bor. Am. 424; Canadian Musci, Geol. Surv., 387. Holz. Musc. Acro. Bor. Am. 162, of *Tayloria serrata*, contains also a sod of this.

On earth, decaying animal carcasses, dung and sewage-soaked wood; Alaska, Greenland, Labrador, Newfoundland, west to Vancouver Island; Washington, Rocky Mountains, Adirondacks, Catskills, White Mountains, Green Mountains.

1a. forma BREWERIANUS (Hedw.) n. comb.

Splachnum Brewerianum Hedw. Descr. 2: 105. pl. 38. 1789; Sp. Musc. 53. 1801.

Splachnum mnioides var. *elongatum* Drum. Musc. Am. 41. 1828.

Tetraplodon mnioides var. *Breweri* (Hedw.) Braithw. Brit. Moss Fl. 2: 112. 1890.

Plants lax, 5-7 cm. high, branches slender, elongate, sparingly leaved; leaves erect, not crisped, lanceolate, about 1.3 x 5 mm., apex yellowish. Seta 1.5-2.5 cm. long; hypophysis sometimes scarcely broader than the capsule. Type locality, England.

EXSICCATI:—Drumm. Musc. Am. 41; Macoun, Hunker Creek, July 23, 1902. Rocky Mountains.

T. mnioides var. *paradoxus* (R. Br.) Hagen, has been reported from Greenland. The leaves are somewhat narrower than in *T. mnioides* and the dehiscence of the operculum is irregular. Some specimens have the operculum half broken loose from the capsule and the columella emergent. An immature form of *T. mnioides* in the Canadian National Museum (Macoun, Bonanza Creek, July 18, 1902) has been called var. *brevicollis* by Kindberg. It has toothed leaves and a long flexuous point sometimes nearly as long as the blade.

2. TETRAPLODON URCEOLATUS (Brid.) Bry. Eur. fasc. 23-24. 1844.

Splachnum urceolatum Brid. Bry. Univ. 1: 242. 1826.

Splachnum Adamsianum Schwaegr. Suppl. 2: pl. 178. 1826.

Plants 1-4 cm. high, strongly tufted, slender, yellow-green above, densely radiculose below the upper 2-5 mm.; leaves imbricated, entire, subcochleariform and very concave, ovate, about 0.8 x 1.5 mm., with a flexuous yellow point sometimes $\frac{1}{4}$ of the leaf, usually hyaline at the summit; costa ending at the base of the point, intercalary cells not different from the comites; leaf cells in the upper part thick-walled, rectangular, 15-18 x 25-30 μ , those at the base long and thin-walled, 18 x 65-70 μ . Autoicous or dioicous, antheridia 0.3 mm., male branches almost leafless; seta stout, yellow becoming red, 3-7 mm. long, not twisted; capsule

cylindric, sometimes contracted below the mouth, horizontal when young, erect and reddish when mature, becoming black with age; exothelial cells transversely elongated at the mouth, below quadrate-hexagonal to rectangular, in the hypophysis rectangular with stomata numerous over the whole surface; calyptra cucullate, 2 mm. long; operculum hemispheric; columella included; *teeth reflexed*, orange, red at the tips, papillose, inserted below the mouth, *in fours then twos*; spores slightly papillose, 7-11 μ , August and September. Type locality, Carinthia, Austria.

ILLUSTRATIONS:—Bry. Eur. *pl.* 290; Broth., Engler and Prantl (Ed. 1) Musci 1: *fig.* 358; *Pl.* 41.

EXSICCATI:—Drumm. Musc. Am. 38 (as *Splachnum*); Macoun, St. Matthew Isl., Behring Sea, Aug. 10, 1891, and Indian Harbor, Labrador, Sept. 6, 1891; Rosenvinge, Plantae Groenlandicae 1888; Canadian Arctic Exp. (1913-1916) 13c, 17, 21.

Alaska, Greenland, Labrador, Behring Sea Region, high Rockies, Colorado. Also subspecies *subrivale* from Labrador by Kindberg (Rev. Bryol. 34: 91. 1907).

3. TETRAPLODON ANGUSTATUS (Hedw.) Bry. Eur. fasc. 23-24. 1844.

Splachnum angustatum [Linn. f.] Hedw. Stirp. Crypt. 2: 35. 1792; Sp. Musc. 51. 1801.

Splachnum setaceum Mich. Fl. Am. Sept. 2: 788. 1803.

Plants 2-8 cm. high, in compact rounded tufts, slender, branched, light green above; *leaves lanceolate-acuminate*, 0.5 x 3-4 mm., *reaching to the capsule* or above it, twisted when dry, distant, *with large teeth to below the middle*, teeth larger in the upper part, occasionally almost entire; lower leaves somewhat broader, brown with radicles; costa excurrent to a flexuous point, occasionally reaching $\frac{1}{2}$ as long as the blade, in cross section having comites surrounded by intercalary cells or intercalary cells ventral; upper leaf cells rectangular, about 15 x 35 μ , sometimes longer, those below 18-30 x 50-90 μ . Autoicous, antheridia and archegonia about 0.3 mm. long; *seta* 2-4 mm. long, pale, *solid when mature*; *hypophysis longer and wider than the capsule*, 1.5-0.8 mm., brownish yellow and *lighter* than the capsule, wrinkled when dry, when wet not constricted below the capsule; capsule erect or occasionally horizontal, reddish, about 0.8 x 1.5 mm., mouth widest when dry and mature; exothelial cells transversely elongated in the upper few rows, quadrate or hexagonal below, rectangular to elongate and thin-walled in the hypophysis with stomata numerous in the upper part; calyptra covering the capsule, cucullate; operculum conic or hemispheric and apiculate; *columella included*; *teeth reflexed* or erect immediately after the operculum is shed, *united in fours*, later in twos; spores 7-11 μ , light green, smooth, July, August and September.

Type locality, Ries Mountains, Germany.

ILLUSTRATIONS:—Bry. Eur. *pl.* 288; Dixon and James. Handb. Brit. Mosses (Ed. 3) *pl.* 35C; Limpr. Laubm. 2: *fig.* 255; Braithw. Brit. Moss Fl. 2: *pl.* 62B; *Pl.* 41.

EXSICCATI:—Drumm. Musc. Am. 42 (as *Splachnum*); Sull. and Lesq. Musc. Bor. Am. (Ed. 1) 152; Canadian Musci 386; Catskills, Beals.

On earth and animal droppings and remains. Newfoundland, Cape Breton, Ontario, Athabasca, British Columbia; Rockies, Minnesota, Catskills, Adirondacks. The habitat of the Drummond specimen is: "Mountain woods; extremely common: upon the dung of the Fox and the Wolf."

4. TETRAPLODON PENNSYLVANICUS (Brid.) n. comb.

Bryum pennsylvanicum Brid. Musc. Rec. 4: 36. 1803 (not of Mant. Musc.)

Splachnum setaceum Hook. and Wils. in Drumm. Musc. Am. S. States. 27. 1841 (not of Mich. 1803).

Tetraplodon australis Sull. and Lesq. Musc. Bor. Am. (Ed. 1) 51. 1856.

Tetraplodon caulescens [L.] Lindb. Krit. Granskn. af Moss. uti Dill. Hist. Musc. 14. 1883.

Plants 1-3 cm. high, very slender, loosely tufted, much branched, green above; *leaves* distant, erect, slightly twisted, *long lanceolate and usually slenderly acuminate*, 0.3-0.5 x 3-5 mm., *often reaching to the capsule* and sometimes above it, occasionally entire but more often *with teeth in the upper half, which may be long and ciliate*; costa stout, percurrent or excurrent to a flexuous point, intercalary cells when present ventral; leaf cells long throughout, 20-30 x 150 μ , lower cells more lax. Autoicous or dioicous, antheridia and archegonia about 0.3 mm.; *seta* soft, almost hyaline, 2-10 mm. long; *hypophysis darker than the capsule*, purplish, varying in size, as long as the capsule or somewhat shorter or longer, as wide or slightly wider but *usually narrower and tapering*, forming a short neck; capsule 1-2 mm. long, elongate-globose, narrowed suddenly to the hypophysis, with the mouth often forming a ridge when dry, orange, becoming dark red with age; exothelial cells transversely elongated in the upper part, hexagonal to the hypophysis, whose cells

are long and thinner-walled; calyptra short, to 0.5 mm., barely covering the operculum, not split or constricted below; operculum conic or hemispheric with a blunt apiculus; columella exerted or included; *teeth reflexed, in fours*, then in pairs, papillose and rather opaque; spores 7-11 μ , light green, smooth, December to May.

Type locality for *T. australis*, on dung of mules in swamps along the eastern coast of the United States.

ILLUSTRATIONS:—Sull. *Icones pl.* 58 (M. H. M. fig. 95); Lesq. and James Mosses of N. Am. *pl.* 4. All as *T. australis*.

EXSICCATI:—Drumm. l. c.; Sull. and Lesq. *Musc. Bor. Am.* (Ed. 1) 157; Austin *Musc. Appal.* 177; Holz. *Musc. Acro. Bor. Am.* 68. The last three as *T. australis*.

Cape Breton, Nova Scotia and along the Atlantic coast from New Jersey to Florida.

This species differs from *T. angustatus* in having the seta softer and almost hyaline, the calyptra shorter and not split, the leaves sometimes more deeply toothed, the hypophysis darker and usually narrower, and in its range. It has been retained in *Tetraplodon* because the teeth are at some time in fours, and are of only two layers (three according to Hagen, *Bryologist* 9: 92. 1906), and because the hypophysis is usually narrower than the capsule.

7. SPLACHNUM [L.] Hedw. *Stirp. Crypt.* 2: 35. 1792; *Sp. Musc.* 51. 1801.

Plants 1-4 cm. high, somewhat caespitose, usually mixed with other mosses; *leaves large, obovate or obovate-lanceolate*, obtuse, acute or acuminate; cells large, mostly somewhat diamond-shaped above and rectangular-elongate below. Dioicous or occasionally autoicous, male flowers terminal on stem or branches with fewer and smaller leaves. Seta 1-20 cm. long, usually erect; *hypophysis usually much wider than the capsule*, of characteristic shape and color within the species; capsule smaller, reddish, cylindric; exothecial cells transversely elongated in the upper 5 or 6 rows, then quadrate-hexagonal and rectangular at the base of the capsule, cells of the hypophysis loose, subquadrate, about 40 μ long; *calyptra short*, reaching to the hypophysis, cucullate, *not constricted below*; operculum conic to hemispheric and apiculate; *columella exerted*, disc red, about 0.3 mm. across; *teeth orange or red, reflexed*, finely papillose, *in pairs* or earlier in fours, *inserted on the rim of the capsule, composed of 3 layers of cells*, of which the outer and inner are transversely elongate and the middle irregularly isodiametric; spores small, about 11 μ , yellow, smooth, maturing in mid-summer.

Type species, *S. vasculosum*.

On the excrement of herbivorous animals, especially on cow dung. Greenland, arctic North America, the southern provinces of Canada; in the United States north-east, north-central and north-west.

KEY.

- | | |
|---|-------------------------|
| 1. Hypophysis more or less globose, rugose when dry; leaves usually under 4 mm. long. | 2. |
| Hypophysis campanulate or umbrella-shaped, smooth; leaves over 5 mm. long. | 4. |
| 2. Leaves entire, acute or obtuse. | 1. <i>vasculosum</i> . |
| Leaves \pm toothed, acuminate. | 3. |
| 3. Hypophysis ovoid, scarcely wider than the capsule; leaves often clustered at the top of the stem, about half as wide as long, marginal teeth small and occasionally absent from some leaves. | 2. <i>ovatum</i> . |
| Hypophysis broadly pyriform; leaves uniform along the stem, less than half as wide as long, marginal teeth large. | 3. <i>ampullaceum</i> . |
| 4. Hypophysis red-purple; leaves toothed nearly to the base. | 4. <i>rubrum</i> . |
| Hypophysis yellow; leaves toothed only in the upper part. | 5. <i>luteum</i> . |

1. SPLACHNUM VASCULOSUM [L.] Hedw. *Stirp. Crypt.* 2: 44. 1792; *Sp. Musc.* 53. 1801.

Splachnum rugosum Dicks. *Pl. Crypt.* 4: 3. 1801.

Splachnum heterophyllum Drumm. *Musc. Am.* 37. 1828.

Plants about 3 cm. high, loosely tufted, usually mixed, green to dark green above; *upper leaves erect*, rather distant, *obovate*, 2.5 x 4 mm., *entire, bluntly acute to obtuse*, lower leaves ovate, obtuse, smaller; costa stout, ending below the apex, intercalary cells surrounding the comites, or intercalary cells dorsal; leaf cells diamond-shaped, about 40 x 90 μ , longer at the base, marginal cells rectangular, yellow. Dioicous, anther-

idia about 0.4 mm.; seta 1-3 cm. long, reddish-orange, erect or flexuous, twisted, hyaline just below the capsule; *hypophysis* ovoid, broader above, tapering below, becoming slightly campanulate, red-purple and rugose when mature, about 3 mm. long and about the same width at the top; capsule dark orange, about 1 mm. long, cylindric, widest at the mouth when dry, capsule and hypophysis both becoming purple-black with age; operculum hemispheric, sometimes obliquely apiculate; teeth about 0.3 mm. long and 40 μ wide; spores 8-11 μ , smooth, greenish-yellow, in summer.

Type locality, Harz Mountains, Germany.

ILLUSTRATIONS:—Bry. Eur. *pl.* 294; Dixon and James. Handb. Brit. Mosses (Ed. 3) *pl.* 341; Limpr. Laubm. 2: *fig.* 258 (capsule only); Broth. Laubm. Fenn. *fig.* 43D (capsule); Braithw. Brit. Moss Fl. 2: *pl.* 61B; *Pl.* 41.

EXSICCATI:—Drumm. Musc. Am. 34 and 37; Holz. Musc. Acro. Bor. Am. 192 (Sweden).

Especially on cow dung; Greenland, Labrador, Hudson's Bay, Sitka. The habitat of Drummond 37 is: "Near a saline spring amongst the mountains, where no other vegetable existed; and upon the dung of some animal."

2. SPLACHNUM OVATUM [Dicks.] Hedw. Sp. Musc. 54. *pl.* 8. 1801.

S. sphaericum [Linn. f.] Sw. Meth. Musc. 33. *pl.* 1. 1781.

S. ovatum Dicks. Fasc. Pl. Crypt. 2: 2. 1790.

S. gracile Dicks. Fasc. Pl. Crypt. 4: 3. 1801.

S. pusillum P. Beauv. Prodr. 89. 1805.

S. refractum Brid. Muscol. Rec. Suppl. 1: 145. 1806.

S. pedunculatum [Huds.] Lindb. Musc. Scand. 19. 1879.

S. intermedium Drumm. Musc. Am. 39. 1828.

Plants 0.5-3 cm. high, tufted, light green to green above, much branched; leaves often clustered toward the top of the stem, somewhat crisped when dry, upper leaves obovate-lanceolate to broadly obovate, from a narrow base, about 1.5 x 3 mm., to 2.5 x 6 mm., sometimes smaller (lower leaves narrower), suddenly short-acuminate to almost acute, margins toothed in the upper part to almost entire, marginal cells usually yellow; costa stout, almost as wide as the leaf at the base, narrowing above and ending in the acumen below the apex; leaf cells large, in the upper part \pm diamond-shaped, 20-30 x 50 μ , in the lower part somewhat swollen and elongate, 25 x 80 μ , intercalary cells dorsal. Dioicous, male plant branched, with distant smaller leaves; antheridia and archegonia about 0.4 mm.; seta 1-20 cm. long, normally about 5 cm., straw-colored or red, hyaline at the summit, straight or twisted and often flexuous: *hypophysis* purple, about as long as the capsule or longer, varying in width, usually slightly wider than the capsule, sometimes scarcely rugose when dry, occasionally approaching a campanulate form and deeply wrinkled: capsule and hypophysis 2-4 mm. long; capsule red-orange, drab, sometimes narrower behind the mouth when dry, when wet contracted to the hypophysis; calyptra 0.5-0.8 mm.; operculum hemispheric, apiculate; teeth about 0.7 mm. long, in pairs; spores 7-13 μ , June, July and August.

Type locality, Harz Mountains, Germany.

ILLUSTRATIONS:—Bry. Eur. *pl.* 292; M. H. M. *pl.* 5: *figs.* 10-11 (peristome); Dixon and James. Handb. Brit. Mosses (Ed. 3) *pl.* 34H; Braithw. Brit. Moss Fl. 2: *pl.* 61C; *Pl.* 41.

EXSICCATI:—Drumm. Musc. Am. 35, 36 (as var. *elongatum*), 39 (as *S. intermedium*); Holz. Musc. Acro. Bor. Am. 191 (Sweden); Howell Pac. Coast Pl. (Alaska); McFadden, British Columbia, 7341; Hb. Sulliv. Moss Soc. 2,790 (Brinkman, Alberta); Gorman, Yukon Terr., 1135; Macoun, Canadian Musci 45.

Especially on cow dung in woods and marshes; Iceland, Alaska, Labrador, Manitoba, Alberta, British Columbia, Rocky Mountains.

Very variable, especially in size and length of seta. The leaves are not concave as in *Tetraplodon mnioides*, which in some other ways resembles this.

3. SPLACHNUM AMPULLACEUM [L.] Hedw. Stirp. Crypt. 2: 41. 1792; Sp. Musc. 53. 1801.

S. ampullaceum var. *longisetum* and var. *Turnerianum* Sw. Summa Veg. Scand. 38. 1814.

Plants 1-3 cm. high, light green above, stems almost hyaline; leaves obovate-lanceolate to long-lanceolate below, 1-1.5 x 2.5-4 mm., from a narrow base, acuminate, the acumen composed mostly of the costa, large teeth at the apex and at intervals along the margin to the middle of the leaf, teeth sometimes composed of several cells; intercalary cells of the costa dorsal; leaf cells large, lax, \pm diamond-shaped, about 25 x 100 μ , the

lower longer. Autoicous or dioicous, antheridia 0.7 mm.; seta 0.6–5.5 cm. long, red, slightly twisted, erect or occasionally curved immediately below the hypophysis; capsule and hypophysis sometimes reaching 7 mm. long; *hypophysis* at first green, then turning yellow with the capsule and when mature becoming lilac-purple, much broader than the capsule, 2–5 mm. wide and 1.5 mm. long, *top-shaped*, suddenly broadened above and gradually narrowed below; capsule 1.5 mm. long and 0.5 mm. wide, yellow, later red, cylindric, contracted below, mouth often widest when dry; exothecial cells with thick sinuose walls; calyptra reaching to the hypophysis; operculum conic to hemispheric; teeth yellow, 0.3 mm. long; spores yellow, about 7–11 μ , July and August.

Type locality, Halle, Germany.

ILLUSTRATIONS:—Bry. Eur. *pl.* 293; M. H. M. *fig.* 94; Lesq. and James Manual Mosses N. Am. *pl.* 4; Dixon and James. Handb. Brit. Mosses (Ed. 3) *pl.* 34G; Limpr. Laubm. 2: *fig.* 257; Braithw. Brit. Moss Fl. 2: *pl.* 61B.

EXSICCATI:—Sull. and Lesq. Musc. Bor. Am. (Ed. 1) 153; Ren. and Card. Musc. Am. Sept. 373; Canadian Musci, Geol. Surv., 393; Macoun, Canadian Musc. 2236, 2237.

Especially on cow dung in swamps and bogs; Newfoundland, Quebec to Ontario, in the United States south to New Jersey, Pennsylvania, Ohio, west to Wisconsin.

4. SPLACHNUM RUBRUM [Montin] Hedw. Stirp. Crypt. 2: 51. 1792; Sp. Musc. 56. 1801.

Plants 2–4 cm. high, loosely tufted, often mixed with other species of *Splachnum*, light green above; leaves erect, crowded at the top of the stems, broadly obovate-lanceolate, about 3.5 x 6 mm., acuminate, toothed nearly to the base; costa extending out into the tip, intercalary cells surrounding the comites or intercalary cells dorsal; upper cells diamond-shaped, about 40 x 90 μ , lower lax, longer, marginal cells yellow. Dioicous, antheridia 0.5 mm.; seta 9–12 cm., usually erect, red, darker above except immediately below the hypophysis; *hypophysis* campanulate, 5–11 mm. across, red-purple; capsule orange, about 1.5 mm. long and 1 mm. wide, widest at the mouth when dry; operculum hemispheric to conic; teeth orange, 0.5 mm. long and about 60 μ wide, broader at the base; spores yellow, 7–11 μ , June and July.

Type locality, European.

ILLUSTRATIONS:—Bry. Eur. *pl.* 295; *Pl.* 43.

EXSICCATI:—Drumm. Musc. Am. 32; Macoun, Portage La Loche (Lat. 57), July, 1888; Moser, Hunter's Horn, New Bruns., June, 1892.

Especially on the excrement of cows in the woods; New Brunswick, Maine, Saskatchewan, Rocky Mountains. The specimen from Saskatchewan was communicated to Dr. Grout by W. P. Thompson of the University of Saskatchewan, 1919, with this comment: "Found about 100 miles north of the settled part of Saskatchewan."

5. SPLACHNUM LUTEUM [Montin] Hedw. Stirp. Crypt. 2: 48. 1792; Sp. Musc. 56. 1801.

S. luteum var. *melanocaulon* Wahl. Mag. Naturf. 5: 294. 1811.

S. melanocaulon (Wahl.) Schwaegr. Suppl. 2¹: 28. *pl.* 109. 1823.

S. luteum var. *pygmaeum* Norrlin, Saelsk. pro Fauna et Fl. Fenn. Foerh. 13: 300. 1873.

Plants 2–3 cm. high, loosely tufted; leaves crowded at the top of the stems, erect, scarcely crisped, obovate-lanceolate, tapering to the base, reaching 2.5 x 6 mm., acuminate, somewhat keeled, toothed in and just below the acumen or almost entire, margins reflexed below; costa stout, ending a few cells below the apex, intercalary cells dorsal; upper leaf cells diamond-shaped, 20 x 50–70 μ , lower cells elongate, reaching 150 μ , marginal cells often rectangular and yellow. Dioicous, antheridia and archegonia about 0.5 mm.; seta 2–12 cm. long, pale red, erect, slightly twisted; *hypophysis* when mature umbrella-shaped, 6–11 mm. across, yellow, pale pink when wet, green and rugose-ovoid when young; capsule cylindric, orange or red, about 1.5 mm. long and 1 mm. wide; calyptra 1.5 mm. long, cucullate; operculum hemispheric to conic; teeth about 0.4 mm. long and 40 μ wide, broader at the base; spores smooth, round, 10–15 μ , May to July.

Type locality, European.

ILLUSTRATIONS:—Bry. Eur. *pl.* 296; *Pl.* 43.

EXSICCATI:—Drumm. Musc. Am. 33; Holz. Musc. Acro. Bor. Am. 190 (Sweden); Fowler, New Bruns., May 21, 1872; Macoun, Bonanza Creek (Yukon), July 18, 1902, and Brit. Col. May 13, 1909; Dawson, Canadian Musci 267.

Especially on the excrement of cows in woods, swamps and bogs; Yukon Territory, New Brunswick, British Columbia, Rocky Mountains.

A short form with pale hypophysis has been called *S. melanocaulon* (Wahl.) Schwaegr., but since this kind of variation is found in all the other species of the genus it seems unwise to admit the name.

Family SCHISTOSTEGACEAE.

SCHISTOSTEGA Mohr, Obs. Bot. 26. 1803.

Only one species in the genus or family.

SCHISTOSTEGA PENNATA (Hedw.) Hook. & Tayl. Musc. Brit. 14. pl. 8. 1818.

Gymnostomum pennatum Hedw. Sp. Musc. 31. 1801.*Schistostega osmundacea* [Dicks.] Mohr l. c.

Plants small and slender, reaching 10 mm. high, from a persistent protonema bearing reflecting luminous subspherical cells at the extremities; fertile plants with lanceolate leaves clustered at the top of the stem; sterile plants frondiform, with oblong-lanceolate distichous leaves decurrent into each other, plane, ecostate, entire; leaf cells lax, rhomboidal to rhombic. Dioicous; male and female plants from the same protonema; seta 2-4 mm. long, capsule small, erect, ovoid, 0.5 mm. long; operculum convex, red-margined; peristome and annulus lacking; spores 8-10 μ , mature in spring, rare in N. America. Type locality, European.

ILLUSTRATIONS:—Bry. Eur. pl. 279; M. H. M. f. 93; Braithw. Brit. Moss Fl. 2: pl. 60.

Occasional in caves and dark holes in the mountains of New England, New York, Ohio, and Canada, west to British Columbia, usually on acid substrata. In caves wet at times with salt spray, Mt. Desert Island, Maine. It has persisted for years under the north sill of an open shed facing south on an old farm in Newfane, Vt. I have also collected it in vigorous growth on the almost perpendicular north-facing slope in an old limestone quarry in Stratton, Vt.

On looking into one of these caverns containing the Luminous Moss, the bottom seems covered with a golden-green glow, something like the appearance of a cat's eyes in the dark. In order to see the glow one must look into the cave from the direction from which the light enters, and care must be taken not to shut off all the entering light, as the Luminous Moss, like the moon, shines by reflected light alone. If one attempts to gather the glowing substance he will find nothing but dirt and stones, with possibly a few tiny green plants like those in the figure (M.H.M.). The compound microscope will reveal threads like those shown in the plate, but the lens will show only a cobwebby appearance of fine green threads. This beautiful plant is probably the reality upon which is based the fairy tales of goblin gold. The discovery of this rare and curious plant will repay a search in every dark hole one sees. If present, it can always be seen from the outside, as it cannot grow beyond the reach of light.

Family ERPODIACEAE.*

BY DR. WILLIAM C. STEERE.

Slender to very delicate, soft plants; *stems of very large loose cells*, irregularly branched, rarely almost pinnate; leaves more or less thickly and uniformly arranged, in from four to several rows, more or less spreading when moist, imbricated when dry, often concave, broad, *ecostate*, non-plicate, not bordered, symmetric or slightly to very strongly asymmetric, cells parenchymatous, *usually papillose*, rarely smooth, little differentiated in the leaf angles, *never colored nor forming swollen auricles*. Autoicous; both inflorescences without paraphyses, ♂ inflorescence small, gemmiform, ♀ inflorescence terminal on branches which may be very short and slender, or elongated and similar to sterile branches; perichaetial leaves erect, longer; seta very short; capsule erect, symmetric, very thin-walled, pale, long-persistent; stomata at capsule base; annulus usually present; *peristome generally lacking*, when present, simple, of 16 lanceolate, red, thickly papillose teeth; calyptra mitrate to campanulate, plicate, lobed, rarely non-plicate, deeply incised at one side.

KEY TO GENERA.

- | | |
|---|-------------------------|
| 1. Leaves very obtuse, cells papillose, branches flattened..... | 2. |
| Leaves acuminate, cells smooth, branches terete..... | 3. <i>Venturiella</i> . |
| 2. Ventral leaves not markedly smaller than the dorsal..... | 1. <i>Erpodium</i> . |
| Ventral leaves about one half the size of the dorsal..... | 2. <i>Solmsiella</i> . |

* See Bryol. 8: 71, 9: 37 and 37: 74, and 96-101. Also Bull. Torr. Bot. Club 32: 266. 1905.

1. ERPODIUM (Brid.) C. Müll. Bot. Zeit. 1: 774. 1843.

Plants slender; stems more or less elongated, creeping, rather profusely branched, with short, horizontal, *flattened branches*; leaves imbricate-appressed when dry, spreading when moist, concave, ovate or ovate-lanceolate to almost lanceolate, *very obtuse* (in our species); *cells papillose* (in our species), oval or rounded-hexagonal, smaller and quadrate at the margin, quadrate or transversely elongate in several rows in the leaf angles; perichaetial leaves erect, longer, pale; seta very short, straight; capsule erect, elongated, immersed or exserted; *annulus wide, long persistent*; peristome lacking; calyptra mitrate, *plicate, with the folds dentate above*, lobed at the base. About 25 species known. Type species *E. domingense*.

ERPODIUM DOMINGENSE (Brid.) C. Müll. Bot. Zeit. 1: 774. 1843.

Anoetangium Erpodium domingense Brid. Bryol. Univ. 2: 167. 1827.

Pilotrichum domingense C. Müll. Syn. Musc. Frond. 2: 184. 1851.

Pilotrichum diversifolium Ångstr., C. Müll. Bot. Zeit. 20: 392. 1862.

Erpodium diversifolium (C. Müll.) Par. Index Bryol. (Ed. 1) 484. 1894.

Plants very small, closely appressed to the substratum, bright yellowish-green or sometimes brownish; stems creeping and rooting, compressed, with the leaves, 1.2–1.5 mm. broad; branches short and irregular, *also flattened*; rhizoids exceedingly numerous; leaves tightly imbricated and appressed when dry, widely spreading when moist, complanate, overlapping half their length, more or less dimorphic, the dorsal somewhat asymmetric, ovate, 0.75–0.9 mm. long, 0.4–0.5 mm. wide, the ventral symmetric, lanceolate-lingulate to oblong, 0.6–0.9 mm. long, 0.2–0.3 mm. wide, both kinds concave and usually widely inflexed at the lower margin, ecostate, entire, except for the very papillose margins, apex very obtuse or rounded; cells large, rounded-hexagonal, 14 x 18 μ , translucent or obscure, densely verrucose-papillose, marginal cells 11–12 μ , basal cells somewhat larger, smooth, quadrate. Autoicous; antheridia few, in a small axillary bud, archegonia terminating short lateral branches; apices of perichaetial leaves spreading, seta short, with vaginule 0.5 mm. long, nearly or quite immersed; capsule erect, 1.0 mm. long, cylindrical, pale yellow, darkening with age, contracted below the mouth when dry, walls parenchymatous; *peristome none*, operculum flat to slightly convex, rostrate; calyptra mitrate, lobed, plicate, serrate or crenulate on the folds above, covering only the upper part of the capsule, apparently shed very early; spores green, smooth, 25–30 μ in diameter. Type locality, Santo Domingo.

ILLUSTRATIONS:—Schwägr. Suppl. 3²: pl. 267. 1829–30; Brotherus, in Engler & Prantl (Ed. 2) 11: 2, fig. 421, A–D; Pl. 44.

Known in the United States only from Camp Perry, 3 miles north of Rio Hondo, Cameron County, Texas (E. U. Clover, Feb. 9, 1934); also from Santo Domingo, Hayti, Porto Rico, Jamaica, Yucatan and Guatemala. The usual habitat of the species is on the trunks of trees, although the Texas material was on rotten wood.

2. SOLMSIELLA C. Müll. Bot. Centralbl. 19: 149. 1884.

Very slender plants in loose, appressed mats; stems creeping, usually with few but very stout rhizoids, irregularly to almost pinnately branched, with short, flattened branches; leaves imbricate when dry, spreading when moist, almost plane, *dimorphic*, the dorsal in two rows, *asymmetric*, oval, apex very obtuse or rounded, upper margin curved and plane, the lower straight and inflexed, the ventral in 2 rows, *much smaller*, almost symmetric, ovate-lanceolate, very obtuse; cells oval-hexagonal to rhomboidal-hexagonal, papillose, smaller and quadrate at the basal angles of the dorsal leaves. ♀ inflorescence terminal on very short erect branch; perichaetial leaves erect, ovate-lanceolate, obtuse; capsule exserted, erect, cylindric; *annulus not differentiated, peristome lacking*; operculum obliquely acuminate from a conic base; calyptra covering only the upper part of the capsule, *non-plicate, deeply incised on one side, not lobed, not at all roughened above*. Four species known. Type species *S. ceylonica* (Mitt.) C. Müll.

KEY TO SOLMSIELLA.

- | | |
|--|--------------------------|
| Marginal cells not papillose, differentiated; cell walls brown | 1. <i>S. biseriata</i> . |
| Marginal cells papillose, not differentiated; cell walls colorless | 2. <i>S. Kurzii</i> . |

1. SOLMSIELLA BISERIATA (Aust.) Steere Bryol. 37: 100. (1934.) 1935.

Lejeunea biseriata Aust. Proc. Acad. Nat. Sci. Phila. 1869: 225. 1869.*Erpodium biseriatum* (Aust.) Aust. Bot. Gaz. 2: 142. 1877.

Stems very slender, to 1 cm. long and about 1.0 mm. wide, simple, subjulaceous when dry, resembling short, simple stems of *Frullania squarrosa*; leaves 4-ranked, the dorsal ones broadly ovate-oval, slightly convex, very obtuse, imbricated, convolute-appressed when dry, widely spreading when moist, reddish or fuscous brown, entire, minutely and closely papillose, the whole lower margin strongly recurved, ecostate; cells at the apex hexagonal or rounded, $5 \times 13 \mu$ in diameter, with thick brown walls, basal and central cells longer and narrower; marginal cells translucent, not papillose; ventral leaves much smaller, about one third as wide and two thirds as long, and stipule-like, linear-oblong, plane, attached diagonally to the stem opposite the base of the dorsal leaves, erect, divaricate; rhizoids very stout, reddish-brown, simple, proceeding from the base of the ventral leaves. Fruit unknown.

ILLUSTRATIONS:—Pl. 44.

The type was collected in 1845 near Augusta, Georgia, by W. S. Sullivant, but has not since been re-discovered, perhaps because of its strong similarity to the very common (in the south) *Frullania squarrosa* and other hepatics, a resemblance which is likewise seen in the other members of this family.

2. SOLMSIELLA KURZII Steere, Bryol. 37: 97. (1934.) 1935.

Plants very small, dull or yellowish green, sometimes faintly tinged with brown, creeping in loosely interwoven mats, or solitary; stems rather irregularly branched, 5–10 mm. long, 0.8–1.0 mm. wide (including the leaves), flattened and appressed to the substratum, scarcely julaceous even when dry; branches short, spreading, flattened; rhizoids few, reddish brown, arising from the stem at the bases of the ventral leaves, less stout than in the preceding species. Leaves strongly dimorphic, complanate-foliate, dorsal leaves in two rows, spreading when dry, widely spreading when moist, asymmetric, lower margin widely inflexed, otherwise nearly plane, broadly oblong-oval, ecostate, apex obtuse or rounded, 0.45–0.55 mm. long and 0.25–0.30 mm. wide; cells densely chlorophyllose, but not opaque, all verrucose-papillose, marginal cells papillose, rectangular, not differentiated, central cells oval-hexagonal, $9\text{--}11 \times 14\text{--}17 \mu$, basal-central cells larger and longer; cell walls colorless, transparent, of moderate thickness only; ventral leaves much smaller, about one half the size of the dorsal leaves, widely spreading, nearly or quite symmetric, nearly plane, ovate-oblong, with obtuse or rounded apex, 0.3–0.4 mm. long, 0.12–0.15 mm. wide; marginal cells rectangular, central cells nearly rhombic. Autoicous; ♀ branch short, lateral, leaves few, rather distant, not 4-ranked. Seta solitary, pale, 0.32–0.40 mm. long, the swollen vaginule of about the same length. Capsule erect, cylindric-oval, the urn 0.55–0.65 mm. long and 0.25 mm. wide, not at all constricted under the mouth, wall smooth, pale yellow; operculum asymmetric, apiculate from a short conic base; peristome none; spores 25μ in diameter, very green, minutely granulose; calyptra unknown.

ILLUSTRATIONS:—Steere, l. c.; Pl. 44.

On the trunk of *Magnolia foetida*, Lake Miccosukee, Florida (H. Kurz 85, March 6, 1927). Known only from the type locality.

3. VENTURIELLA C. Müll. Linnaea 39: 421. 1875.

A monotypic genus with only the following species:

VENTURIELLA SINENSIS (Vent.) C. Müll. l. c.

Erpodium sinense Vent. in Rabenh. Bryoth. Eur. No. 1211, cum diagn. 1873.*Erpodium japonicum* Mitt. Journ. Linn. Soc., Bot. 22: 314. 1887.*Venturiella japonica* (Mitt.) Broth. Hedwigia 38: 225. 1899.

Small, dark green plants in thick mats; stems, creeping, flattened, profusely branched, branches erect, about 5 mm. long, terete; leaves imbricate-appressed when dry, widely spreading when moist, very fragile, concave, 1.0–1.3 mm. long, 0.35–0.5 mm. wide, elongated into a denticulate, hyaline hair, stem leaves somewhat dimorphic, the dorsal ovate, slightly asymmetric, the ventral lanceolate-ovate, symmetric; margins plane and entire except at the apex. Upper cells hexagonal, smooth, $21\text{--}25 \mu$ wide and $30\text{--}37 \mu$ long, quad-

rate to transversely elongate in the leaf angles, quadrate at the leaf margin, uppermost rhombic, *elongated and becoming linear in the hyaline acumination*. ♀ inflorescence terminal *on an elongated branch*; perichaetial leaves erect, symmetric, larger, the uppermost 2.0–2.3 mm. long, with long, twisted, serrate, hyaline acumination (about 1 mm. long). Seta very short, 0.5–0.8 mm. long, straight; capsule immersed or emergent, very pale yellow, erect, oval-cylindric, 1.5 mm. long, annulus wide, persistent; *peristome present*, of 16 approximately equidistant, lanceolate, reddish, densely spinulose teeth, inserted near the mouth; operculum with a straight apiculus from a conical base; calyptra inflated-campanulate, *enclosing nearly the whole urn*, plicate, with the folds strongly serrate above, lobed at the base; spores 25 μ , green, finely papillose. Type locality Shanghai, China.

ILLUSTRATIONS:—Mitten, Trans. Linn. Soc., Ser. II. 3: *pl. 51*; Engler & Prantl (Ed. 2) 11: 3. *fig. 422, A–G; Pl. 44*.

Known in North America only from McKittrick Canyon, Guadalupe Mountains (alt. 1980 m.), Culberson County, Texas, collected by Moore and Steyermark July 21, 1931 (no. 3524); also China, Korea, and Japan.

1. Family ORTHOTRICHACEAE.

Mostly dark colored plants growing in tufts or patches on trees and rocks; stems without central strand, erect, or creeping with erect stems and branches, simple or branched above by innovations mostly; leaves mostly unistratose though frequently bistratose in parts, crowded, appressed or crispate when dry, spreading to squarrose when moist, keeled, often concave at base, lanceolate to ovate-lanceolate, less frequently lingulate, often bearing septate brood bodies; margins mostly entire, often strongly revolute; costa strong, usually nearly or quite percurrent; upper leaf cells small, usually 8–15 μ in diameter and irregularly rounded, incrassate and papillose on both sides; at base of leaf, rectangular, rhomboidal to linear, often colored; perichaetial leaves little differentiated (except in *Amphidium*); sporophytes mostly terminal; capsules immersed to exserted, erect and symmetric, usually long-necked or pyriform, often 8-plicate when dry and empty, ovoid to oblong-cylindric; annulus generally present but of small, little differentiated cells which little resemble those of *Funaria* or the *Hypnaceae*; exothelial cells mostly differentiated along the folds or ribs; stomata present and characteristic; peristome usually present and double; teeth sometimes with a preperistome or partial extra outside lamina; teeth 16, often united in pairs, usually papillose and striate in a way peculiar to each species; segments of inner peristome almost without basal membrane, slender, thin and hyaline, 8 or 16, alternate with the teeth, often lacking; operculum convex to conic-rotate; calyptra mitrate, usually hairy, often companulate, smooth to strongly plicate.

(A key to the genera will be given at the end of the treatment of the family.)

ORTHOTRICHUM Hedw. Musc. Frond. 2: 96. 1788; Sp. Musc. 162. 1801.

Plants growing chiefly in temperate and subalpine climates, usually in small tufts or cushions on trees, less frequently on rocks, mostly dark green to brownish except in the young growing parts; leaves mostly lanceolate, hygroscopic, spreading when moist,* appressed when dry, only rarely much contorted or crisped, generally recurved to revolute at the margin; upper leaf cells small, little longer than broad, angular to rounded, usually papillose, with papillae usually much more conspicuous on young leaves; lower cells often less incrassate, quadrate to rectangular, less dense, usually smooth at or near the insertion,† less incrassate and shorter in young leaves. Base of the short seta inserted in a minute cup-like sheath, the ochrea; capsules immersed to emergent, sometimes fully exserted, usually with 8–16 regular folds or plicae forming ribs when dry, occasionally smooth (the folds consisting of larger and darker cells than the intermediate exothelial walls), elliptic or pyriform to cylindric, with a more or less tapering neck, sometimes contracted below the mouth, especially when old; peristome of 16 broadly lanceolate teeth, often united in pairs, and often recurved when dry, sometimes erect at first and when old recurved (lacking in *O. gymnostomum*); inner peristome, when present, of 8 or 16 narrow segments, often called cilia; stomata scattered, often nearly covered by exothelial cells (immersed); annulus of small thin cells without cavity (see illustrations); calyptra campanulate, usually hairy, lobed at base, plicate. Type species *O. anomalum*.

* Water seems to be absorbed more rapidly on the inner face of these basal cells than on the outer surface as the leaves are often recurved when first moistened but straighten in a few minutes.

† Apparently the size and translucency of basal cells depends a great deal on the size, vigor and rapidity of growth of the plants.

The old capsules often appear lateral by reason of innovations.

A most difficult genus because most of the distinguishing characters are found in the sporophyte. Calyptra, ripe operculate capsules, and old empty capsules are often needed to identify a plant with certainty. Sterile specimens are mostly exceedingly difficult or impossible to name with certainty. In addition many species vary greatly in the characters used to characterize the species. Even worse the nomenclature is in an almost hopeless muddle, due largely to the carelessness or indifference of authors. Brotherus lists 189 species, of which 58 are credited to North America. This number exceeds all reasonable belief. Type specimens, in many cases have been studied by so many bryologists that there is little of value left. These older types have not been examined by the author except in special cases. The opinions of competent observers has usually been taken with references to most of the older types, in particular those of Mrs. Britton expressed in volumes 20 and 21 of the Bulletin of the Torrey Botanical Club.

The position of the stomata may be immersed (cryptore), or superficial. In the latter case the entire reniform guard cells are visible. To study the stomata satisfactorily the capsule may be cut off near the base, split in half and the halves mounted outside up after removing any contents. Before dissecting the capsule it should be soaked until the air is removed or else boiled vigorously. Another very satisfactory method is to place the seta with capsule after soaking on a blank slide and roll it flat with the handle of a dissecting needle. This usually leaves the peristome in condition and removes the spores so that the stomata can be seen.

GROUP ARRANGEMENT OF ORTHOTRICHUM.

I. RUPESTRIA Hagen (emend).

- | | | |
|---------------|--------------------|----------------|
| 1. rupestre | 7. Holzingeri | 13. praemorsum |
| 2. texanum | 8. fenestratum | 14. speciosum |
| 3. Macounii | 9. cancellatum | 15. elegans |
| 4. Roellii | 10. affine | 16. Lyellii |
| 5. laevigatum | 11. sordidum | 17. striatum |
| 6. Bolanderi | 12. microblepharum | |

STROEMIA Hagen (as a genus).

- | | | |
|------------------|-----------------|-------------|
| 18. obtusifolium | 19. gymnostomum | 20. exiguum |
|------------------|-----------------|-------------|

RIVULARIA Venturi.

- | | | |
|--------------|-------------|-----------------|
| 21. rivulare | 22. Sprucei | 23. euryphyllum |
|--------------|-------------|-----------------|

CUPULATA.

- | | | |
|---------------|------------------|----------------|
| 24. anomalum | 27. strangulatum | 30. alpestre |
| 25. cupulatum | 28. Lescurii | 31. Jamesianum |
| 26. urnigerum | 29. Hallii | |

TENELLA.

- | | | |
|--------------|--------------------|---------------|
| 32. tenellum | 33. cylindrocarpum | 34. Bartramii |
|--------------|--------------------|---------------|

STRAMINEA.

- | | | |
|---------------------------|--------------|---------------|
| 35. pallens var. parvulum | 37. ohioense | 39. Garrettii |
| 36. stellatum | 38. pumilum | 40. pusillum |

PULCHELLA.

- | | |
|----------------|---------------|
| 41. pulchellum | 42. consimile |
|----------------|---------------|

DIAPHANA.

- | |
|---------------|
| 43. diaphanum |
|---------------|

KEY.

- | | |
|---|----------------|
| 1. Upper leaves with long, serrate hyaline points. | 43. diaphanum. |
| Leaves without hyaline points, or if present only a few cells (1-4) long. | 2. |
| 2. Leaf margins plane or involute throughout. | 3. |
| Leaf margins revolute for at least a portion of the length. | 4. |

- | | |
|--|---------------------------|
| 3. Leaf margins plane or slightly incurved; peristome present..... | 18. <i>obtusifolium</i> . |
| Leaf margins strongly involute; peristome lacking..... | 19. <i>gymnostomum</i> . |
| 4. Stomata superficial (phaneropore)..... | A. |
| Stomata immersed (cryptopore)..... | B. |

A.

- | | |
|--|-----------------------------|
| 1. Growing on trees; peristome teeth mostly reflexed to revolute when dry*.... | 2. |
| Growing on rocks; peristome teeth mostly erect to spreading when dry..... | 10. |
| 2. Dioicous..... | 3. |
| Monoicous..... | 4. |
| 3. Peristome segments fully as wide as teeth; small, southeastern; leaves about 1 mm. long..... | 20. <i>exiguum</i> . |
| Peristome segments linear-filiform; western; leaves 3-4 mm. long..... | 16. <i>Lyellii</i> . |
| 4. Capsules nearly or quite exserted..... | 5. |
| Capsules immersed to emergent..... | 8. |
| 5. Plants small, rarely over 1 cm. in height; capsules smooth even when old; found only east of the Rocky Mountains..... | 15. <i>elegans</i> . |
| Plants larger; capsules more or less ribbed when old; found only west of the Rockies..... | 6. |
| 6. Capsule smooth until old and empty; frequent within its range..... | 14. <i>speciosum</i> . |
| Capsules plicate when mature and dry; rare..... | 7. |
| 7. Leaves nearly smooth; capsules long-exserted; peristome teeth smooth but with a strong preperistome..... | 7. <i>Holzingeri</i> . |
| Leaves strongly papillose; capsules immersed to barely exserted; teeth granulose, without preperistome..... | 9. <i>cancellatum</i> . |
| 8. Capsules smooth when dry, completely immersed..... | 17. <i>striatum</i> . |
| Capsules strongly ribbed when dry; exothelial cells plainly differentiated along the ribs..... | 9. |
| 9. Capsules mostly emergent, oblong-cylindric when moist, narrowly cylindric when dry; western..... | 10. <i>affine</i> . |
| Capsules immersed to slightly emergent when moist, pyriform, less shrunken when dry; eastern..... | 11. <i>sordidum</i> . |
| 10. Leaf margins plane in the upper one half..... | 6. <i>Bolanderi</i> . |
| Leaf margins revolute nearly to apex except in young leaves..... | 11. |
| 11. Capsules immersed to emergent (see also vars. of <i>microblepharum</i>)..... | 12. |
| Capsules exserted or nearly so..... | 14. |
| 12. Peristome teeth mostly erect when dry; leaves obtuse to broadly acute..... | 13. |
| Peristome teeth reflexed when dry; leaves slender pointed..... | 13. <i>praemorsum</i> . |
| 13. Peristome teeth lightly papillose to nearly smooth..... | 1. <i>rupestre</i> . |
| Peristome teeth, warty or irregularly roughened at base..... | 2. <i>texanum</i> . |
| 14. Capsules strongly ribbed when dry..... | 12. <i>microblepharum</i> . |
| Capsules smooth except when old and empty..... | 15. |
| 15. Peristome teeth striate..... | 4. <i>Roellii</i> . |
| Peristome teeth papillose..... | 16. |
| 16. Leaves broadly obtuse or blunt..... | 5. <i>laevigatum</i> . |
| Leaves abruptly acute to slenderly pointed..... | 17. |
| 17. Capsules oblong-cylindric; peristome teeth rarely perforate..... | 3. <i>Macounii</i> . |
| Capsules ovoid-pyriform with a long neck; peristome teeth perforate..... | 8. <i>fenestratum</i> . |

* Rupestral species are often found at base of trees and arboreal species are frequently found on soil rich in vegetable matter. *O. alpestre* seems to grow well on either substratum. Many species have the peristome teeth erect until a considerable time after dehiscence, and later spreading to recurved.

B. (stomata immersed).

- | | |
|---|-----------------------------|
| 1. Aquatic or growing on wet rocks or wood; leaves broadly obtuse..... | 2. |
| Not aquatic, mostly xerophytic; leaf apices various..... | 3. |
| 2. Many leaves denticulate at apex; leaf cells 10-12 μ in diameter..... | 21. <i>rivulare</i> . |
| Leaves entire or rarely with a single apiculus; leaf cells 12-20 μ in diameter.. | 22. <i>Sprucei</i> . |
| 3. Growing on rocks; peristome teeth mostly erect to spreading when dry..... | 4. |
| Growing on trees; peristome teeth mostly reflexed when dry..... | 13. |
| 4. Capsules plainly exserted, wet or dry..... | 24. <i>anomalum</i> . |
| Capsules immersed to emergent..... | 5. |
| 5. Leaves oblong to oblong-lanceolate, rounded-obtuse..... | 31. <i>Jamesianum</i> . |
| Leaves oblong-lanceolate to lanceolate; apex slenderly or broadly acute..... | 6. |
| 6. Peristome teeth striate, at least above..... | 7. |
| Peristome teeth papillose (<i>alpestre</i> may be sought here)..... | 10. |
| 7. Peristome teeth papillose at base, vertically striate at apex (nearly smooth or papillose at apex in varieties)..... | 30. <i>alpestre</i> . |
| Peristome teeth striate throughout..... | 8. |
| 8. Peristome single; most leaves obtusely acute..... | 9. |
| Peristome double; most leaves slenderly acute..... | 26. <i>urnigerum</i> . |
| 9. Upper part of leaf bistratose; capsules mostly oblong..... | 29. <i>Hallii</i> . |
| Upper part of leaf unistratose; capsules mostly subglobose..... | 25. <i>cupulatum</i> . |
| 10. Capsule abruptly narrowed to the seta..... | 11. |
| Capsule gradually tapering to the seta..... | 27. <i>strangulatum</i> . |
| 11. Leaves entire, none hyaline-apiculate..... | 12. |
| Leaves, especially the upper, denticulate and hyaline-apiculate at apex..... | 39. <i>Garrettii</i> . |
| 12. Leaves broadly lanceolate, 3-4 mm. long; calyptra naked; very rare, western... | 23. <i>euryphyllum</i> . |
| Leaves narrowly lanceolate, mostly less than 2.5 mm. long; a few hairs present in the calyptra..... | 28. <i>Lescurii</i> . |
| 13. Capsules smooth or slightly wrinkled when dry and old..... | 40. <i>pusillum</i> . |
| Capsules strongly ribbed, especially when old..... | 14. |
| 14. Leaves imbricate when dry, not noticeably crisped or contorted..... | 15. |
| Leaves contorted to crisped when dry..... | 22. |
| 15. Capsules exserted or nearly so..... | 33. <i>cylindrocarpum</i> . |
| Capsules immersed to emergent..... | 16. |
| 16. Upper and perichaetial leaves more or less denticulate..... | 34. <i>Bartramii</i> . |
| Leaves entire..... | 17. |
| 17. Stomata in neck of capsule..... | 32. <i>tenellum</i> . |
| Stomata in walls of spore sac..... | 18. |
| 18. Stomata with guard cells largely exposed..... | 35. <i>pallens</i> . |
| Stomata with guard cells mostly hidden..... | 19. |
| 19. Leaves mostly obtuse..... | 20. |
| Leaves mostly acute..... | 21. |
| 20. Capsules straw-colored, only slightly contracted below the mouth when dry and empty..... | 37. <i>ohioense</i> . |
| Capsules dark colored, strongly plicate and contracted below the mouth when dry and empty..... | 36. <i>stellatum</i> . |
| 21. Leaf cells 10-12 μ in diameter, thick-walled; peristome teeth striate above... | 30. <i>alpestre</i> . |
| Leaf cells 12-16 μ , thin-walled; peristome teeth papillose throughout..... | 38. <i>pumilum</i> . |
| 22. Peristome teeth dark red-orange; capsule immersed..... | 41. <i>pulchellum</i> . |
| Capsules exserted or nearly so; peristome teeth pale..... | 42. <i>consimile</i> . |

1. ORTHOTRICHUM RUPESTRE Schleich. Crypt. Helv. exsic. Cent. III. no. 24. 1806.

Orthotrichum Sturmi Hoppe & Hornsch. Flora. 1: 341. 1818 and 2: 89. 1819.

Orthotrichum rupicola of Drumm. Musc. Am. 156. 1828.

Plants in more or less dense tufts or cushions, olive-green above, brown to almost black below, rather stiff when dry; stems erect, 3-5 cm. long, or ascending and reaching 10 cm., more or less branched; leaves

lanceolate, tapering to a narrowly obtuse or rarely acute apex, reaching 5 mm. in length, spreading to recurved when moist, keeled; margins strongly recurved to near apex; costa nearly or quite reaching the apex; leaf cells thick-walled, irregular or rounded above, $8-12\ \mu$ in diameter, $1-2 : 1$, mostly unistratose, sometimes partially bistratose (or in forms of three layers in part) papillose with papillae sometimes with two points; basal cells smooth, rectangular, linear in some of the upper leaves, $2-6 : 1$, with cell walls often more or less nodose and occasionally nearly as wide as the lumen; at basal angles a small area of quadrate cells. Autoicous; antheridial buds on axillary branches near the archegonial; capsules immersed to emergent, oblong to ovoid, light brown or yellowish; urn $1.75-2.5$ mm. long, typically with a tapering neck but frequently there are forms with neck short or almost wanting, scarcely contracted below mouth when dry and empty, except when very old, with eight more or less conspicuous ridges when dry and empty, rarely with faint intermediate folds; exothecial cells little differentiated, rather long; stomata superficial, usually near base of spore sac, bordering cells not radiating; annulus double, persistent, of two rows of cells; operculum rounded-conic, apiculate to short-rostrate; peristome teeth 16, erect or spreading, at first often united in pairs, quite variable, solid or more or less perforate along the median line, smooth to faintly papillose, sometimes with faint sinuous lines; segments well developed, of two rows of cells to short and rudimentary or even wanting; calyptra hairy, plicate, with long spinulose hairs covering most of the capsule; spores $\pm 15\ \mu$, papillose roughened, maturing in spring. Type locality, the Tyrol.

ILLUSTRATIONS:—Bry. Eur. *pl.* 217; Husnot, Musc. Gall *pl.* 44; Braithw. Brit. Moss Fl. *pl.* 55B; *Pl.* 45.

EXSICCATI:—Allen, Mosses Cascade Mts. 40, 41; Holz. Musci. Acro. Bor. Am. 314; Grout, Musci Perfecti 224 (near var. *ovalum*).

On rocks and ledges containing little or no lime, in subalpine habitats, Rocky Mts. and westward, north to British Columbia, south to Texas.

An exceedingly variable species in the characters that have been used to characterize forms that have been raised to specific rank by various authors. The following characters have been used to define related species and varieties: e. g. *O. Sturmii*, bi-tristratose leaves, peristome teeth smooth and segments lacking; capsules abruptly contracted to the seta.

These are precisely the characters in which *O. rupestre* is most variable and these variations not only do not seem to be correlated but even vary on the same plant. Venturi states that rare forms have capsules without ribs. He also states that if the exterior teeth are well developed and papillose, one finds that the segments more or less developed; these latter are ordinarily wanting if the teeth are incompletely developed or smooth.

Allen, Mosses Cascade Mts. 40 has well developed segments and a capsule abruptly narrowed to the seta with smooth peristome teeth. R. & C. Musc. Eur. 176 has capsules as described for *O. Sturmii*. Specimens determined as *O. Sturmii* by Carl Mueller have the slender tapering neck of *O. rupestre*.

Venturi states (Musc. Gall. 146) that on the same plant some leaves may be unistratose and others almost entirely of two layers. In young leaves the basal cells are mostly rectangular, $2-4 : 1$, scarcely incrassate. In older leaves the cell walls sometimes become almost as thick as the remaining lumen is wide and often strongly nodose. This is true of both American and European plants.

As a rule the marginal cells of *O. rupestre* are quadrate or very short-rectangular to near the insertion where they frequently become larger, thinner-walled and slightly inflated. The size of the leaf papillae varies a great deal but as a rule they are larger and more conspicuous in American plants.

It may be *O. rupestre* as here treated is a composite species but it seems useless to segregate species from our forms, based only on one or two variable and inconstant characters.

1a. Var. GLOBOSUM (Lesq.) n. comb.

O. texanum globosum Lesq. Mem. Calif. Acad. Sci. 1: 17. 1868.

Calyptra naked or with very few short nearly smooth hairs, capsule globose to short pyriform, completely immersed.

Holzing, Musc. Acro. Bor. Am. 314 and 288 (in part, as *O. Bolanderi*).

"We have a fragment of this variety from the type specimen, and have examined the capsules. They are short, immersed or only partly exerted, globose-pyriform, with a tapering neck, peristome single, teeth pale, smooth or with faint traces of thickening ridges as in *O. texanum*, but not papillose. The spores are small, .016-.018 mm., warty and brown and the calyptra sparsely hairy. Our capsules are too young to show the ridges of the walls, the cells being still full of chlorophyll, though the spores are ripe. It would seem as if the thickening of the teeth and the ridges of the capsules were a later development."

"Type locality, 'Nevada Falls, Yosemite, California, Bolander.'" Mrs. Britton, Bull. Torr. Bot. Club 21: 140. 1894.

Perhaps only an immature form of *O. rupestre*.

1b. Var. *MACFADDENAE* (Williams) n. comb.

Orthotrichum MacFaddenae Williams, Bryol. 31: 52. pl. 5. 1928.

Leaves 3-4 mm. long, basal cells oblong to linear-flexuose, very incrassate with nodose walls, capsules slightly emergent when dry, with perichaetial leaves reaching slightly beyond when moist. Capsule oblong to oblong-obovoid, light colored, very slightly or not at all ribbed until old; exothecial cells not clearly differentiated; peristome teeth smooth in the type, slightly papillose in other similar forms. Type (studied by courtesy of New York Botanical Garden, R. S. Williams) from Roseberry, B. C., on rocks (Mrs. F. A. MacFadden, May 2, 1927.) The light colored slightly striate capsules are very striking.

EXSICCATI:—Holzinger, Musc. Acro. Bor. Am. 368, Washington (as *O. Douglassii*). This contains a form of *O. affine* in some sets). Flattop Mt., Rocky Mt. Park, Colo. Ruth Ashton no. 284, alt. 12,000 ft. July 19, 1931. Very near var. *ovatum* Vent. Musc. Gall. 155, if not identical.

2. *ORTHOTRICHUM TEXANUM* Sull. in Sull. & Lesq. Musc. Bor. Am. (Ed. 1) 122. 1856.

Orthotrichum bullatum C. Muell. Flora 70: 223. 1887 (type seen).

Resembling *O. rupestre* and easily confused with it; sterile plants are seemingly indistinguishable. The capsules are smooth or somewhat wrinkled; the exothecial cells thin-walled and short, scarcely differentiated; *peristome teeth roughened with coarse irregular projections* which are neither papillae nor striae, more or less perforate above; segments poorly developed or lacking. Pl. 46.

EXSICCATI:—Sull. & Lesq. l. c.; Macoun, Can. Musci 350 and 331, as *O. Roelli*.

The Sull. & Lesq. no. 122 from Texas (Wright) is clearly the type and the capsule is smooth as described on the label; no. 187 of the second edition is not the same as it has smooth peristome teeth. Its leaves are rather broader and more obtuse than the general run of *rupestre* to which it seems to belong. Sullivant's Icones pl. 34 and the accompanying description fit no. 187 fairly well.

O. texanum seems fairly common in the Rocky Mountain region. It occurs on rocks from Texas to British Columbia.

The best developed form of *O. texanum* seems to be found in the Colorado Rockies; the teeth are perforate and very rough; the leaves are very strongly papillose. From *O. rupestre* var. *MacFaddenae* it differs chiefly in the rough peristome teeth; from *O. laevigatum* in the less exerted capsules, more wrinkled when dry and old, rough peristome teeth and more narrowly acuminate leaves.

3. *ORTHOTRICHUM MACOUNII* Austin, Bull. Torr. Bot. Club 6: 343. 1879.

Orthotrichum Schlotthaueri Vent. Bot. Centralbl. 44: 39. 1890.*

Orthotrichum stenocarpum Vent. l. c. (Not of Bridel, Bry. Univ. 1: 271. 1826.)

Plants in dense robust tufts, olive-green above, brownish below; stems about 1-3 cm. long, sparingly branched; leaves loosely imbricate when dry, erect-spreading when moist, lanceolate to ovate-lanceolate, very slenderly acute at apex, reaching 4 mm. in length, with costa subpercurrent, otherwise much as in *O. rupestre*. Autoicous; capsules exerted on a 2-4 mm. seta, light brown to straw color, cylindric when dry, smooth or slightly ribbed when very old, with a moderately long wrinkled and twisted neck, oblong to ovoid when moist; urn 2-2.5 mm. long; annulus and exothecial cells much as in *O. laevigatum* except that the cells seem longer; stomata superficial, few; operculum short-rostrate; calyptra hairy, plicate; exothecial cells long and narrow, little differentiated, longitudinal walls incrassate; peristome teeth 16, sometimes united in pairs at first, light colored, coarsely papillose, sometimes transversely striate at base, articulations fairly prominent; segments 8, narrow, shorter than the teeth, smooth or nearly so; spores 12-15 μ in diameter, maturing in summer. Type locality, on rocks, Cascades, British Columbia, May 17, 1875 (Macoun).

ILLUSTRATIONS:—Pl. 46.

EXSICCATI:—Idaho Plants, A. A. & Gertrude Heller, 3047; Macoun, Can. Musci. 454; Holzinger, Musc. Acro. Bor. Am. 212 (as *O. laevigatum*). On rocks, Alaska, British Columbia, Washington, Idaho, Montana, Utah; Newfoundland (Waghorne).

Distinguished from *O. rupestre* and its varieties by the slender-pointed leaves. Through var. *lonchothecium* it grades into *O. laevigatum*.

The co-type of *O. Schlotthaueri* from Sun River Canyon, Montana (Williams) cannot be distinguished from *O. Macounii*, the capsules of which are often slightly ribbed when dry and old.

* See Bull. Torr. Bot. Club. 21: 144-145. 1894.

3a. Var. *LONCHOTHECIUM* (C. M. & Kindb.) n. comb.

Orthotrichum lonchothecium C. M. & Kindb. Cat. Can. Pl. 6: 90. 1892.

Leaves rather blunt as in *O. rupestre*. Co-type seen from Deer Park, Lower Arrow Lake, Columbia R., British Columbia, Macoun, Can. Musci 497. Also from Kootenai Lake, B. C.

Distinguished from *O. laevigatum* by its more slender-pointed leaves and elongate exothecial cells. The peristomes are similar.

EXSICCATI:—Can. Musci. l. c.; Plants of Wyoming (Goodding) 479; Colorado (Crandall 21).

4. *ORTHOTRICHUM ROELLII* Vent. Bot. Centralbl. 44: 360. 1890.

Plants closely caespitose, about 2 cm. high, freely divided; leaves broadly lanceolate to ovate-lanceolate, rather broadly acute as a rule, 2.5–3.5 mm. long, loosely appressed-imbricate when dry, strongly papillose except at base; margins strongly revolute to near apex; costa strong, reaching into the apex; upper leaf cells 7–12 μ in diameter, rounded, thick-walled, dense, isodiametric to oval; basal quadrate to rectangular or oblong, seldom much more than 2 : 1, except close to base of costa. Autoicous; seta 1–2 mm. long; capsules exserted, smooth or lightly plicate when dry and empty, with a long tapering neck; urn about as long as the seta; calyptra plicate, hairy; operculum conic-rostrate; annulus present, below it 4–6 rows of small rounded thick-walled cells; exothecial cells little differentiated along the folds; stomata superficial, scattered in the middle portion of the capsule, with surrounding cells shorter but not radiating; peristome double, the teeth 16, more or less closely united in pairs, erect when dry, *striate rather than papillose; segments slender, nearly as long as the teeth*, of two rows of rather irregular cells, smooth; spores about 15 μ , very finely papillose, maturing in spring. Type from rocks at Thorp, near Ellensburg, Washington (Roell).

ILLUSTRATIONS:—Pl. 46.

EXSICCATI:—Holzinger, Musc. Acro. Bor. Am. 660 (as *O. Schlotthaueri*); Sandberg and Leiberg, Plants of the State of Washington, 856, Spokane, May, 1893.

On rocks, Washington and California, British Columbia. The leaves are much like those of *rupestre*, except for the shorter basal cells. The exserted nearly smooth capsules are much like those of *Macounii*. The striate teeth distinguish it from both.

5. *ORTHOTRICHUM LAEVIGATUM* Zett. Bull. Soc. Bot. Fr. 1862: 287. 1862.

Orthotrichum rhabdophorum Vent. Bot. Centralbl. 44: 8. 1890.

Orthotrichum Douglasii Duby, Mém. Soc. Phys. d'Hist. Nat. de Genève, 19: 293 pl. 1, f. 2. 1868. (Type seen.)

Plants dark brownish-green almost to the tips, 5–25 mm. high, more or less branched above, growing in rather loose tufts; leaves erect-open when moist, broadly lanceolate to ovate-lanceolate, *narrowly obtuse*, 2–4 mm. long, young leaves sometimes acute; margins revolute nearly to apex; costa stout, mostly dorsal, extending nearly or quite to the apex; upper leaf cells dense, irregular, rounded, nearly isodiametric, in-crassate, papillose (papillae* simple, bifid or trifid, strongly salient), 10–12 μ in diameter, rarely in two layers above; basal cells oblong to rectangular, translucent but often somewhat colored, with walls becoming thickened and often somewhat nodose when old, 9–15 μ wide, 2–4 : 1 near the costa; marginal shorter, subquadrate. Autoicous; antheridial buds axillary; *capsules exserted on a seta reaching 2–4 mm. long, about ½–¾ the length of the seta, ovoid to oblong-ovoid, when dry and empty cylindric, with a short or rather long neck, wrinkled when very old, otherwise smooth or nearly so except at the neck*; operculum short-rostrate; annulus persistent; below the annulus 4–6 rows of small thick-walled cells gradually merging into the slightly differentiated (i. e. nearly uniform all around) oblong to rectangular exothecial cells; stomata superficial, few, in lower ½ of capsule; bordering cells shorter but not radiating; peristome teeth erect† or inclined inward, 16, united in pairs at first, sometimes perforate above, articulations strongly marked, papillose; segments varying from well developed to almost lacking; calyptra hairy, reaching to the mouth of

* On young leaves the papillae seem very large and prominent, but on most of the older leaves they seem lower and rounded; in any case the papillae vary greatly on leaves of the same plant.

† Venturi Musc. Gall. 158, states that the teeth are erect in the type; later in Hedwigia 33: 227. 1893, he states that they are reflexed as in *O. speciosum* as stated by Schimper. In American plants referred to this species they are erect, also in specimens from Norway, dist. Hagen.

the capsule; spores 10–15 μ , lightly papillose, maturing in early spring. Type locality near Rodsheim, Norway.

ILLUSTRATIONS:—Husnot, *Musc. Gall.* *pl.* 44; *Bry. Eur. Suppl.* *pl.* 2; *Pl.* 47.
On rocks; Nevada, Wyoming, California, Utah, Idaho, Oregon, Washington, British Columbia.

5a. Var. *KINGIANUM* (Lesq.) n. comb.

Orthotrichum Kingianum Lesq. *Mem. Calif. Acad. Sci.* 1: 18. 1868.

Costa usually ending well below apex of leaf; upper leaf cells reaching 15 μ in diameter, usually smaller; capsule longer and narrower, with a long neck, pyriform when moist; articulations of teeth indistinct; segments shorter than the teeth, of two rows of cells. Type locality, Falls of the Yosemite (Bolander). (Type seen.) Also in Idaho; doubtfully worthy of even varietal rank.

ILLUSTRATIONS:—Sull. *Icones Musc. Suppl.* *pl.* 55; *Pl.* 45.

O. laevigatum like *O. rupestre* varies a great deal but the bluntish leaves, sharply papillose with protruding sharp papillae and the fully exerted smooth capsule with superficial stomata, can usually be depended on. *O. rhabdophorum* Vent. is a form with capsules plicate when old. Norwegian specimens from Hagen show that character; also the capsules are long-necked.

6. *ORTHOTRICHUM BOLANDERI* Sull. *Icones Musc. Suppl.* 64. *pl.* 46. 1874.

Plants almost black throughout, reaching 3.5 cm. in length, more or less branched above; leaves lanceolate, often ovate at base, closely appressed-imbricate when dry, \pm 3 mm. long, broadly keeled, with margins narrowly reflexed when dry, *when moist, plane in the upper $\frac{1}{2}$ and almost opaque*, due to a double layer of small (7–10 μ) rounded, incrassate, papillose cells; median basal cells rectangular, 2–4 : 1, marginal shorter; costa stout, vanishing in the apex. Autoicous; calyptra hairy; seta about 1 mm. long; capsules emergent, more or less 8-ribbed when dry and empty, with conic-apiculate operculum and neck about 2 mm. long, oblong-ovoid; annulus present; stomata superficial; peristome teeth 16, united in pairs, strongly papillose; segments linear, nearly as long as the teeth, of two rows of cells, somewhat papillose; spores \pm 20 μ , ripening in early spring. Type locality, on rocks, California (Bolander).

ILLUSTRATIONS:—Sull. l. c.; *Pl.* 45.

EXSICCATI:—Holzinger, *Musc. Acro. Bor. Am.* 288. This seems to be mixed. In the set at the U. S. National Museum it is correct, in my set it is *O. rupestre* while 643, issued as *O. affine* is *O. Bolanderi*.

On rocks; apparently confined to southern California; San Gabriel Mts. (Kingman) and Los Angeles Co. (Geo. L. Moxley).

Seemingly the peristome teeth may be incurved or recurved according to conditions little understood, perhaps age; one capsule had teeth in both positions; the normal condition would seem to be reflexed or recurved. I have observed the same thing in *O. affine*. As Sullivant remarks (l. c.), it is a fine and very distinct species but the most evident distinction is in the leaves and not in the capsule. When the leaves are mounted they lie almost flat on the slide.

The fact that Dr. Venturi could place this as a mere variety of *rupestre* indicates poor judgment on his part or else the lack of authentic material.

7. *ORTHOTRICHUM HOLZINGERI* R. & C. *Contrib. U. S. Nat. Herbarium* 3: 270. 1895.

Plants large, reaching 2 cm. or more in height, in loose wide cushions, very dark green; stems freely branching; leaves oblong-lanceolate, 2.5–3 mm. long, loosely imbricate when dry, narrowly obtuse, the lower much smaller; costa nearly or quite percurrent; upper leaf cells irregularly rounded, nearly isodiametric, about 10 μ in diameter, dense, *nearly or quite smooth*; basal rectangular, hyaline or slightly colored. Autoicous; seta 3 mm. long; capsule long-exserted, oblong-cylindric with a long neck gradually narrowed to the seta, 8-ribbed when dry, about 2.5 mm. long; annulus present; exothelial cells scarcely differentiated; 6–8 rows of small rounded incrassate cells below the annulus; stomata superficial, in lower part of spore sac, surrounding cells radiating; peristome teeth 16, erect when dry, smooth, preperistome very marked, *reaching* 3–4 articulations high, often double at base and fragmentary to the middle of the teeth; segments apparently wanting but capsules old and deoperculate. Type locality, Lewiston, Nez Perces Co., Idaho, Sandberg, MacDougal and Heller, *Plants of Northern Idaho* 1155. *Pl.* 48A.

Apparently on soil over rocks, as there is much earth and sand in the plant tufts. Might pass for *O. laevigatum* except for plicate capsules, and strongly developed preperistome. Cardot states that the calyptra is naked in the type but that in specimens from Mt. Hood, Oregon it is hairy. He does not mention the preperistome.

8. *ORTHOTRICHUM FENESTRATUM* Cardot & Thériot, Proc. Wash. Acad. Sci. 4: 310. pl. 16, f. 2a-2n. 1902.
(Translated from the original.)

Monoicous, laxly pulvinate, dark green, blackish below, stems much divided, 1-1.5 cm. long; leaves erect, imbricated when dry, scarcely spreading when moist, the upper larger, lanceolate to ovate-lanceolate, acute; margins entire, revolute nearly to apex; costa narrow, vanishing below apex; lower cells subhyaline, rectangular, 2-4 : 1, shorter toward the margins, with nodose walls; median and upper irregular, round or short ovate, 9-12 μ in diameter, with thick walls. Male flowers sessile under the female; capsule on a short (1-2 mm.) seta, long-(?) exserted,* pale yellow, ovoid-pyriform, *subglobose when dry, abruptly contracted at base, when moist gradually narrowed into a long slender neck, smooth or nearly so*, including the neck 3 mm. long and half as thick; stomata superficial; exothelial cells only slightly differentiated; operculum slightly convex, rostrate; calyptra conic-companulate, plicate, bearing a few whitish hairs; vaginula naked; peristome seemingly smooth, teeth 16, united in pairs, pale yellow, granulose, erect or spreading when dry, *cancellate and cribose perforate in the upper part*. Pl. 48C.

From St. Paul Id., Behring Sea, Macoun. July 30, 1891.

"This moss was distributed as *O. anomalum* but bears no resemblance to that species. It is allied to *O. cribrum* C. Muell. from the Chukchi peninsula, Siberia, chiefly by the shape of the capsule and the structure of the peristomial teeth, but it differs from it by its larger size and the leaf areolation, composed of less incrassate and less papillose cells."

The pale straw colored, goblet-shaped, exserted capsules and perforate peristome teeth with very thick dark projections at the joints, but irregularly placed, are very striking and distinctive.

9. *ORTHOTRICHUM CANCELLATUM* Card. & Thériot, Univ. Calif. Pub. Bot. 2: 299. 1906.

Monoicous, somewhat densely pulvinate; stems branching, 1-1.5 cm. high; leaves imbricated when dry, erect-spreading when moist, the median 1.5-1.7 mm. long, 0.4-0.5 mm. broad, acute or mucronate, the upper larger, lanceolate or ovate-lanceolate; margins entire, revolute nearly to apex; costa narrow, vanishing below the apex, 50-65 μ thick at base; lower leaf cells hyaline or pellucid, rectangular, towards the margins shorter, subquadrate, smooth; median and upper unequal, subcircular to ovate, chlorophyllose, papillose, 12-18 μ in diameter, with thick walls; male flowers under the female; perigonal leaves short, ovate, obtuse, ecostate, entire. *Capsules immersed on a seta 0.5 mm. long, ovoid-pyriform, gradually attenuate to the seta by the neck when moist; when dry 8-ribbed, contracted under the mouth, without operculum 1.2 x 0.9 mm.; stomata superficial; exothelial cells differentiated; calyptra conic, plicate, brown at the apex, bearing a few white hairs; vaginula naked; peristome double, the outer of 16 teeth united in pairs, or sometimes separate, reflexed when dry, granulose, perforate and appendiculate-cancellate in the upper part; segments shorter, granulose; spores very large, 30-35 μ in diameter, papillose.* (Translated from the original.)

Type in herb. Thériot and a portion in herb. A. J. G., kindly sent by M. Thériot. Type locality, Cape Dyer, Norton Sound. Pl. 48B.

"By the elegant structure of the peristomial teeth, this interesting species comes very near *O. fenestratum* Card. & Thér. but differs from it by its smaller size, shorter stems, shorter and more papillose leaves and the capsule immersed, sulcate in the dry state."

In the specimens sent me the capsules were almost exserted, all of the capsule except the lower neck being above the perichaetial leaves; the leaves reached more than 2 mm. in length and were almost as strongly papillose as in *O. alpestre*; the markings on the teeth are coarse, elongated and irregular but too short to be called striae.

10. *ORTHOTRICHUM AFFINE* [Schrad.] Brid. Musc. Recent. 2^o: 22. 1801.

Plants in rather small loose tufts, dull green, 1-3 cm. high, branching freely above; leaves more or less closely imbricated when dry, oblong-lanceolate, acute to subacute, 3-4 mm. long, margin recurved to the apex; costa nearly or quite percurrent; upper leaf cells irregularly rounded, isodiametric to slightly elongated, papillose, 12-15 μ in diameter; median basal cells smooth, elongated, subrectangular, rather thin-walled, subhyaline with walls becoming slightly thickened and nodose with age, marginal shorter; perichaetial leaves more or less obtuse. Autoicous; *capsules emergent to almost exserted, oblong-cylindric*, strongly 8-ribbed and shrunken, but not urceolate when dry and empty, with a long tapering neck and on a seta $\pm \frac{1}{2}$ its length; calyptra slightly hairy; operculum conic-rostellate; annulus present, below it 4-5 rows of small

* Cotype seen; in this the capsules were barely exserted.

thick-walled, transversely elongated cells; exothelial cell walls of ribs strongly differentiated; stomata superficial, near the middle of the spore sac; peristome teeth 16, united in pairs, reflexed when dry, trabeculate and perforate above, papillose, the papillae sometimes arranged in lines; segments 8, of two rows of cells, papillose, slender; spores 15–20 μ , maturing in early summer. Type locality, Germany.

ILLUSTRATIONS:—Bry. Eur. *pl.* 216; Braithwaite, Brit. Moss Fl. 2: *pl.* 55D; Husnot, Musc. Gall. *pl.* 47; *Pl.* 47.

EXSICCATI:—Grout, N. Am. Musci Perfecti, 99 (as *O. sordidum*); Holzinger, Musc. Acro. Bor. Am. 366 (also as *O. sordidum*).

On trees, Rocky Mts. and westward, rarely on rocks. Apparently rare in most parts of North America; frequent in Utah. Often confused with *O. speciosum*, which has fully exerted capsules, nearly smooth until empty and exothelial cells only slightly differentiated. *O. Lyellii* has much more slender-pointed leaves, much more strongly papillose. *O. sordidum*, which takes the place of *affine* in the East, is at best only a subspecies, the capsules are shorter, ovoid, lighter colored and with exothelial cells less strongly differentiated. *O. fastigiatum* Bruch, has been reported from Lake Superior but is probably only *O. sordidum*, which it strongly resembles. It however has the differentiated exothelial cells of *O. affine*. Bolander's plant from California which has been referred to *O. Shawii** Wilson (see Bull. Torr. Bot. Club 21: 139. 1894) has been examined and it fits *O. fastigiatum* perfectly except that the exothelial cells are only slightly differentiated. It is clearly a depauperate form of the *affine* group. The leaves are far too blunt for *O. Shawii*.

The perichaetial leaves of *O. affine* are occasionally markedly obtuse. A plant included in some packets of Holzinger's Musci Acrocarpi No. 368 (as *O. Douglasii*) has lingulate rounded-obtuse perichaetial leaves; this I have designated.

Forma OBTUSA n. forma.

Folia perichaetialia lingulata.

Port Angeles, Washington (Foster), type; Mill Creek Canyon, Salt Lake City, Utah (Flowers).

Flower's plants have peristome segments of two rows of irregular cells and simulate *O. fastigiatum*, which at best is only a variety of *affine*. A somewhat similar form is in the herbarium of the U. S. National Museum, Sandberg and others No. 1102 from Hope, Kootenai Co., Idaho, Aug. 1892 (as *O. fastigiatum*), also another from "Lea's Farm," Canada (Macoun), June 6, 1908.

*11. ORTHOTRICHUM SORDIDUM Lesq. & James, Aust. Musc. Appal. 168. 1870.

Subspecies of *O. affine*. Leaves more abruptly acute. Capsules immersed or slightly exceeding the perichaetial leaves, ovoid-pyriform (neck as long as spore case), shorter, on a seta less than 0.5 mm. long, lighter colored, light yellow, less strongly ribbed; urn 1.2–1.6 mm. long; exothelial cells less strongly differentiated; spores in spring. Type locality, Cambridge, Massachusetts.

ILLUSTRATIONS:—Sull. Icones Musc. Suppl. *pl.* 49; M. H. M. *pl.* 39.

EXSICCATI:—Austin, l. c. (There is some *O. ohioense* in some packets of Austin's 199, as in specimen in U. S. Nat. Museum).

Common on bark of trees in the northeastern U. S. and southeastern Canada; south to New Jersey.

Closely resembles *O. affine fastigiatum*, but that variety has the strongly differentiated exothelial cells as figured by Limpricht, 2: 82. f. 237. The perichaetial leaves nearly or quite reach the mouth of the urn when dry and sometimes reach beyond. Sometimes the peristome teeth remain erect for a considerable time; occasionally the capsules are very slightly ribbed, simulating *O. pusillum*.

12. ORTHOTRICHUM MICROBLEPHARUM Schimp. Bry. Eur. Suppl. fasc. 1–11. *pl.* 2. 1864.

Orthotrichum Blythii Schimp. Bry. Eur. l. c. *pl.* 3.

Orthotrichum idahense Card. & Thér. Bot. Gaz. 30: 19. *pl.* 5. 1900. (Type seen.)

Orthotrichum Pylaisii Brid. Bryol. Univ. 1: 722 & 790. 1826?

Orthotrichum Breutelii Hampe; Sendt. Flora 32: 273. 1849?

Orthotrichum Barthii Sendt. Flora 32: 273. 1849?

Orthotrichum arcticum Schimp. l. c. *pl.* 5.

Orthotrichum groenlandicum Berggr. in K. Sv. Vet.-Akad. Handl. 1875: no. 8, 23.

Plants in dense wide tufts, brownish below, olive above, 1–3 cm. high; leaves much as in *O. laevigatum*, appressed-imbricate when dry, ovate-lanceolate, recurved on the borders almost to the apex, obtuse to

* *Orthotrichum Shawii* Wilson; Bry. Eur. Suppl. fasc. 1–2. 1864 (not of DeNot.). Known definitely from one place in England only. All reported American specimens are very doubtful.

broadly acute; leaf cells rounded and densely papillose above with one or more simple or forked papillae, variable on different leaves of the same plant, at times papillose along the margins almost to the insertion; basal cells rectangular and smooth as a rule. Autoicous; capsule nearly or quite exserted on a seta 1-2 mm. long, pyriform, when dry urceolate and abruptly narrowed to the twisted neck, strongly plicate with 8 ribs, appearing much as in *Ulotia crispa* var. *crispula*; stomata, superficial, mostly near the base of the spore sac, often in groups of 2-5; annulus persistent; below it 5-9 rows of small thick-walled rounded cells; operculum conic-apiculate; calyptra covering the capsule, hairy; peristome teeth 16, united in pairs, finely and densely papillose, more or less trabeculate and perforate at apex, closely reflexed when dry; segments 8, linear, shorter than the teeth, of 1-2 rows of cells, often poorly developed, slightly papillose as a rule; spores 16-21 μ , finely papillose, maturing in spring. Type locality, Norway.

ILLUSTRATIONS:—Bry. Eur. 1. c.; Husnot, Musc. Gall. pl. 47; Pl. 47.

On rocks in high altitudes; Disco Island, Greenland; Newfoundland (Waghorne); Labrador, Isles aux Coudres in the St. Lawrence River (Victorin); Kodiak Island (Macoun); Pribiloff Islands (Merriam); Unalaska with *Ulotia phyllantha* (Flett). On trees, Lake Superior, Macoun, Can. Musc. 122 (as *O. sordidum*); Nevada Co., California, alt. 6500-7000 ft. (Leiberg Nos. 5474, 5472, 5468, 5469). Leiberg's & Flett's material has capsules less contracted under the mouth than typical. On trees, Grand Marais, Cook. Co., Minn., Holzinger. A distinct and interesting species. *O. arcticum* as described and figured differs mainly in the less exserted capsule with less prominent ribs and shorter seta. Reported from Greenland and Kodiak Island.

O. microblepharum is, according to Venturi (Husnot, Musc. Gall. 175), little more than a form of *O. Blythii*. As *O. microblepharum* is the first described and figured it seems that name should be used instead of *O. Blythii*. Venturi farther says: "although I think that the European species of the subsection *Orthotricha* *Arctica*, i. e. *O. microblepharum* Schimp., *O. Blythii* Schimp., *O. arcticum* Schimp., *O. Sommerfeltii* Schimp., *O. brevinerve* Lindb., *O. Breutelii* Hamp., *O. Pylaisii* Brid., *O. Barthii* Sendt. and *O. caucasicum* Vent. are only a single species with two or three varieties, I dare not treat them as simple synonyms for they are rare and confined to regions so difficult of access that I am not able to say the last word."

Through the kindness of Dr. H. J. Möller, the writer has seen type duplicates of *O. groenlandicum* and has been unable to find any important differences from *O. microblepharum*. *O. Breutelii* and *O. Barthii* have also been reported from Greenland.

A very vigorous and freely fruiting form of *O. microblepharum* was collected on the bones of a child on St. Lawrence Island, Behring Sea by a government teacher, Vere Gambell (herb. N. Y. Botanical Garden).

The St. Lawrence River, Lake Superior, and Minnesota specimens have dark orange teeth, colored much like those of *O. pulchellum*. No other differences of importance seemed present. For this form I propose the name

Forma RUBRUM n. forma.

Peristomium luteo-rubrum.

*13. *ORTHOTRICHUM PRAEMORSUM* Vent. Bot. Centralbl. 44: 418. 1890.

Differs from *O. microblepharum* chiefly in the slender pointed leaves and emergent capsule on shorter seta. On rocks, Yellowstone National Park, Wyoming. Roell, 1491.

From all other forms of the *Orthotricha arctica* this is distinguished by the slender pointed leaves. A portion of the type is at the New York Botanical Garden but no capsules are present.

14. *ORTHOTRICHUM SPECIOSUM* Nees in Sturm, Deutsch. Fl. 2: fasc. 17. 1819.

Orthotrichum speciosum var. *polycarpum* Lesq. & James, Manual N. Am. Mosses, 169. 1884.

Orthotrichum Ravi Austin, Bull. Torr. Bot. Club. 6: 343. 1879.

Plants in tufts loose to dense, green to yellow-green above, 1-4 cm. high, branching, leaves oblong-lanceolate to elongated-lanceolate, acute to very slenderly acuminate, keeled, loosely imbricate when dry, reaching 3-4 mm. long; costa nearly or quite percurrent; margins recurved nearly to apex except in young or perichaetial leaves; basal leaf cells quadrate at the margins, near the costa long-rectangular, with longitudinal walls becoming very thick and nodose with age, gradually merging into the upper rounded or oblong incrassate cells, which are 12-15 μ in diameter (18-20 μ according to Limpricht), strongly papillose with one or more strong sharp, simple or bifid papillae. Autoicous; seta 1.5-2 mm.; capsule greenish, changing to light yellow, nearly or quite exserted, with a long neck of thin tissue, cylindric to oblong-ovoid when dry, nearly smooth until empty, then slightly narrowed under the mouth and lightly plicate the whole length when old; urn about 2 mm. long with 8 bands, clearly indicated by bands of differentiated exothecial cells with thicker

walls; stomata superficial, surrounded by shorter cells; calyptra hairy; operculum conic with a beak equal to its diameter, red-bordered; annulus present, below it 3-5 rows of small rounded incrassate cells; peristome teeth 8, geminate, rarely separating, strongly papillose, often perforate, when dry typically revolute and touching the outer capsule wall with their tips; segments 8, well developed, nearly as long as the teeth, of two rows of cells rather irregular in outline, often appendiculate, papillose; spores 15-25 μ in diameter, papillose, maturing in early summer. Type locality, Germany.

ILLUSTRATIONS:—Bry. Eur. *pl.* 217; Braith. Brit. Moss. Fl. 2: *pl.* 564; Husnot, Musc. Gall. *pl.* 46; M. H. M. *f.* 92. (This represents the dry capsule of *elegans* better than *speciosum*.)

EXSICCATI:—Holzinger, Musc. Acro. Bor. Am. 494, 111 & 592 (as *O. affine*); Allen, Mosses Cascade Mts. 44; Drumm. Musc. Am. 158.

Mostly on trees, sometimes on noncalcareous rocks in the West. California to British Columbia and Alaska. Forms agreeing with the European are more common in the Rocky Mts. and westward. In these the capsules are lightly 8-striate when old, dry and empty and the cells in these wrinkles are differentiated. This form is rare or absent in the East. Frequently the teeth do not become recurved until some time after the operculum falls.

14a. Var. *KILLIASII* (C. Muell.) n. comb. ?

Orthotrichum Killiasii C. Muell. Bot. Zeit. 17: 166. 1859. Jahresb. naturf. Ges. Graubünd. 3: 160. 1858.

A depauperate alpine form of *O. speciosum* growing on rocks in denser cushions, with dense appressed leaves, much shorter and with very large forked papillae; segments broader with rarely a trace of 8 intermediate ones. Disco Island, Greenland.

14b. Var. *HAINSLAE* (Aust.) Paris, Index Bryol. (Ed. 1) 896. 1894.

Orthotrichum Hainsiae Aust. Bull. Torr. Bot. Club. 1. c. 342.

Dark, depauperate plants with spreading leaves, capsules smaller and less exserted, almost smooth calyptrae and smaller more immersed capsules. Type from rocks in the Rocky Mts.

*15. *ORTHOTRICHUM ELEGANS* Hook. & Grev. Edinb. Journ. Sci. 1: 122. *pl.* 6. 1824. (Sometimes cited as Brewster's Journal.) Also of Schwaegr. in Richards. Frankl. Narr. App. 28 (name only).

Orthotrichum speciosum var. *Roellii* Vent. Bot. Centralbl. 44: 419. 1890.

Orthotrichum speciosum of most American authors.

Subspecies of *O. speciosum*; plants smaller, rarely much over 1 cm. in height, darker green; leaves less slenderly pointed, with very much smaller and usually simple papillae; capsules nearly or quite exserted; oblong-obovoid, smooth, nearly cylindric when dry; urn about 2 mm. long; exothelial cells nearly uniform; peristome teeth with up to 14 joints; spores in summer.

Type locality, on trees between lat. 54° & 64° N. Am. Dr. Richardson, . . . gathered upon an overland N. Am. expedition with Dr. Franklin.

ILLUSTRATIONS:—Hook. & Grev. Edinb. Journ. Sci. 1. c. *pl.* 6; *Pl.* 50D.

EXSICCATI:—Aust. Musc. Appal. 172 (as *O. leiocarpum*); Drumm. Musc. Am. 155.

Common on trees in the northern U. S. and southern Canada, mostly east of the Mississippi; Minnesota (Holzinger). This eastern form is distinctly different from the western form which the author collected several times in the Colorado Mountains. This western form has numerous stomata scattered in the lower $\frac{2}{3}$ of the capsule. In the eastern form the exothelial cells are sublinear and the walls very incrassate, nearly equal to the lumen and the stomata are few and near the base of the spore sac.

In the European specimens studied the size of the plants and the wrinkling of the old capsules, as well as the salient papillae, are like those of our western plants but the exothelial walls and the stomata approach the eastern.

In the original publication, this is put under the group, "cilia 8, capsules immersed." The original description and notes follow:—

"Caulibus erectis, foliis lanceolatis subrecurvis acutis, capsula oblongo-cylindracea laevis; peristomii dentibus, octo revolutis, ciliis filiformibus, calyptra pilosa.

"Specimens scarcely exceed an inch in length and resemble *O. affine* but the color is a pale yet bright green, the capsule is decidedly smooth and the calyptra more hairy."

On p. 124 l. c. treating of *O. speciosum* Nees, Hooker says, "likewise has its capsule subimmersed and perfectly smooth in which respect it agrees with *O. elegans*."

Also, "Hedwig's figures (St. Cr. 2: pl. 36, f. 1-3 excluding no. 9) are admirably characteristic of this species." Of *O. speciosum* he says "Capsula leviter sulcata."

The only discrepancy in the original description is "capsules subimmersed" which is not true of the usual run of specimens. The plants were named by Schwaegrichen but not described.

16. *ORTHOTRICHUM LYELLII* Hook. & Taylor, Musc. Brit. 76. pl. 22. 1818.

Plants robust, 2-6 cm. high, brownish- to olive-green above, brown below, in rather loose soft tufts; stems erect to ascending, branched; leaves in European plants bearing numerous brown septate brood bodies, long and narrowly lanceolate from an oblong base, 3-4 mm. long, mostly rather rigid and closely imbricate, varying to loosely imbricate and almost crisped in a few instances, when moist widely spreading, more or less *undulate near apex, acute; margin usually plane and somewhat irregular in outline above* and often finely and sharply denticulate with large papillae, usually plane at base and somewhat revolute for a varying distance in the widest part; *leaf cells typically papillose with large salient conical to linear papillae* except near the insertion; basal cells oblong-linear, smooth, usually incrassate, sometimes as thick-walled as the upper, gradually changing into the rounded or elliptical, strongly incrassate upper cells, 10-12 μ in diameter; papillae, in the lower portion of the leaf at least, occasionally bifid. *Dioicous*; calyptra large, oblong-conic, hairy; seta about 0.5 mm. long; capsules immersed to emergent, oblong-ovoid with a neck often as long as the urn proper, which is 1-2 mm. long, with 8 well marked ribs when dry; operculum conic-rostellate; annulus present; exothelial cells well differentiated along the ribs; stomata superficial, very few, near base of spore sac; peristome double, teeth 16, slender, densely and finely papillose, revolute when dry; segments large, of two rather irregular rows of cells, papillose, nearly as long as the teeth, easily broken; spores 25-35 μ in diameter, maturing winter to early spring. Type locality, European.

ILLUSTRATIONS:—Bry. Eur. pl. 221; Husnot, Musc. Gall. pl. 46; Braithwaite, Brit. Moss Fl. 2: pl. 56B; Pl. 49.

EXSICCATI:—Baker, Pacific Coast Bryophytes, 354; Howe, Musc. Calif. 22 & 53.

On trees; California. Most of the material labeled *Lyellii* from North America is the variety *papillosum*. True *Lyellii* is rare in North America. I have examined dozens of specimens of this and its varieties and have found but one, Abrams, 3790, California, in the U. S. National Museum, comm. N. Y. Botanical Garden, that had the characteristically abundant brood bodies.

16a. Var. *PAPILLOSUM* (Hampe) Lesq. & James Manual, 178. 1884.

Orthotrichum papillosum Hampe, Linnaea 14: 458. 1860.

Orthotrichum Menziesii Hook., Mitten, Journ. Linn. Soc. 8: 24. 1865.

Orthotrichum Sullivantii Bauer, Austin, Bull. Torr. Bot. Club 6: 33. 1879.

Orthotrichum strictum Vent. Bot. Centralbl. 44: 419. 1890.

Orthotrichum Lyelloides Kindb. Rev. Bryol. 23: 11. 1896.

Orthotrichum papillosum Howei R. & C. Bot. Gaz. 30: 20. 1900.

Plants lighter colored; stems less rigid; leaves with a much longer and more slender apex, reaching 5 mm. in length, almost always without any brood bodies; capsules nearly always more emergent with a longer seta (up to 1.5 mm.) and a shorter neck.

EXSICCATI:—Holzinger, Musc. Acro. Bor. Am. 493; Baker, Pacific Coast Bryophytes 88. Common in the Rocky Mts. and westward; Texas (Wright).

16b. Forma *PRINGLEI* (C. Muell.) n. comb.

Orthotrichum Pringlei C. Muell. Bull. Torr. Bot. Club 13: 121. 1886.

The extreme form of var. *papillosum*; leaves with long slender apices, at times almost filiform, contorted to crisped in the upper portion of stems and branches when dry.

EXSICCATI:—Holzinger, Musc. Acro. Bor. Am. 189 & 367; Sull. & Lesq. Musc. Bor. Am. (Ed. 2) 185; Allen, Mosses Cascade Mts. 43.

The nearly plane margined leaves and the dioicous inflorescence easily distinguish all forms of this from the related species. All sorts of variations and gradations are found between the typical *Lyellii* and f. *Pringlei*. North American plants as a rule have leaves broader at the base than the European and the European plants vary more in the direction of var. *papillosum* than the manuals indicate. A plant in the

U. S. National Museum from St. Leonard's Forest, England, April, 1846, has crispate leaves and as large papillae as any observed in American plants.

The leaves of the male plants appear to be more slender than those of the female.

A form collected on rocks in Gray Eagle Valley, Nevada Co., California, alt. 6,500 ft., (Leiberg No. 5471), has the margins revolute nearly to apex in most leaves. It is very dark in color with very thick cell walls throughout, apparently an arctic-alpine form.

17. *ORTHOTRICHUM STRIATUM* [L.] Hedw. Sp. Musc. 168. 1801.

Orthotrichum leiocarpum Bry. Eur. fasc. 2-3. pl. 220. 1837.

Plants in irregular and often rather loose tufts, deep to yellowish-green above; stems erect to ascending, 1-5 cm. long, branching; leaves loosely imbricate when dry, long-lanceolate and slender pointed, 3-4 mm. long; margin recurved or revolute nearly to the often serrulate apex; costa extending nearly to the apex; leaf cells unistratose, median basal oblong to sublinear, more or less incrassate; marginal subquadrate and main body of cells irregularly rounded, elliptic to circular above, incrassate, bearing simple papillae. Autoicous; seta very short; capsules immersed, smooth, brownish to straw colored, oblong to ovoid, slightly contracted below the mouth when dry and empty but without traces of striae; calyptra straw colored, hairy; stomata superficial; annulus present; operculum conic, red at margin; peristome teeth 16, of many articulations, recurved when dry, densely and evenly papillose; segments 16, nearly as long as the teeth, of two very irregular rows of cells, papillose, erect; spores lightly papillose, about 25 μ in diameter, maturing in early spring. Type locality, European.

ILLUSTRATIONS:—Bry. Eur. l. c.; Husnot, Musc. Gall. pl. 45; Braithw. Brit. Moss Fl. 2: pl. 56C; Pl. 40.

EXSICCATI:—Sull. & Lesq. Musc. Bor. Am. (Ed. 1) 121c, (Ed. 2) 183; Drumm. Musc. Am. 154; Aust. Musc. Appal. 172; Allen, Mosses Cascade Mts. 37 (as *O. laevigatum*).

Very rare in N. America, growing on the bark of trees; Vancouver Id., Washington, Idaho, near Lake Superior and probably elsewhere in the northwestern U. S. & western Canada. Allen's plants are a lax slender form with slender leaves, called by Venturi forma *laxa*. The *Bryum striatum* of Linnaeus was apparently so called from the calyptra as the species is one of the very few with entirely smooth capsules.

18. *ORTHOTRICHUM OBTUSIFOLIUM* [Schrader] Brid. Musc. Recent. 2²: 23. 1801.

Plants in small dense irregular tufts, light to yellow-green; stems \pm 1 cm. high with few turgid branches above, occasionally with slender sterile small-leaved shoots; leaves closely imbricated when dry, widely spreading when moist, reaching 2.5 mm. in length, broadly ovate to oblong-lingulate, concave with margins plane (rarely slightly incurved in the middle in western forms), mostly broadly obtuse at apex (occasionally some of the leaves on a plant narrowly obtuse to subacute), entire, except for marginal papillae, decurrent; costa ending below apex; brood bodies commonly present and abundant; leaf cells bearing on both sides, except near the base, large blunt papillae, double or single; upper cells rounded, incrassate, about 12 μ wide and a little longer; at base marginal quadrate to short-rectangular, near the costa elongated-rectangular; perichaetial leaves broader. Dioicous; male plants smaller; capsules immersed or emergent in American forms on a very short seta, ovoid to elongated-pyriform, with neck as long as the spore case, when dry 8-ribbed and contracted under the mouth; calyptra bell-shaped, naked, rough at apex; stomata superficial, very few; operculum conic-apiculate; annulus present, below it 7-9 rows of very small, quadrate to transversely elongated cells; peristome double, teeth 16, united in pairs except at the tips, densely and finely papillose, reflexed when dry, reddish; segments 8, nearly as long as the teeth, of two rows of cells, rather wide; spores finely roughened, maturing in spring. Type locality, near Göttingen, Germany.

ILLUSTRATIONS:—Bry. Eur. pl. 208; Braithw. Brit. Moss Fl. 2: pl. 55; Husnot, Musc. Gall. pl. 52; M. H. M. f. 91.

EXSICCATI:—Sull. & Lesq. Musc. Bor. Am. (Ed. 1) 116; Holzinger, Musc. Acro. Bor. Am. 594; Bartram, Mosses S. Arizona 152; Grout, Musci Perfecti, 100; Aust. Musc. Appal. 164.

On bark of deciduous trees; southern Canada across the continent, north to Alaska; south to Maryland and Arizona. Frequent in New England. Does not fruit freely.

19. *ORTHOTRICHUM GYMNSTOMUM*, Bruch in Brid. Bryol. Univ. 1: 782. 1826.

Plants in yellowish-green tufts reddish brown within; stem $\frac{1}{2}$ to 1 cm. tall, erect, rigid, usually simple, sometimes branching, with one or more clavate innovations; leaves when dry closely imbricated, when moist

spreading, oblong-ovate, concave-carinate, broadly obtuse *with the margin involute except at the base*, 2-2.5 mm. long; costa narrow, disappearing under the apex; perichaetial similar but longer, oblong-lanceolate, often plane at the rounded or blunt apex; middle basal cells broadly linear, quadrate at the angles, upper oblong-rhomboidal, apical oval or roundish, $\pm 15 \mu$ in diameter, each cell with one or two stout papillae, these sometimes bifurcate. Dioicous; male plants smaller, in separate tufts or mixed with the female; calyptra plicate, conical, hairless, rough and black at apex, scarcely covering one-third of the capsule; operculum narrowly conical from a convex base; capsule immersed, oblong-ovate, oblong when dry and empty, rounded at the truncate base, *without peristome*, neck shorter than spore sac, stomata superficial, only a few and these near the mouth; ribs eight, yellowish, composed of two to four rows of yellowish thick-walled cells; seta very short; spores in spring. Type locality, European.

ILLUSTRATIONS:—Husnot, *Musc. Gall. pl. 52*; Bry. Eur. *pl. 208*; *Pl. 49*.

Known in North America from one station only; upper Sandy Point, Newfoundland, on aspens, April 28, 1894 (Waghorne).

Sterile, it can easily be distinguished by the strongly involute margins, in many leaves being incurved even around the broad apex, making the leaves almost cymbiform.

20. ORTHOTRICHUM EXIGUUM Sull. Mosses U. S. 33. 1856.

Plants small, less than 5 mm. high, dark green; leaves appressed when dry, oblong, lower smaller and subacute, the upper and perichaetial much larger and obtuse, reaching 1 mm. in length; margins more or less reflexed, especially below; costa strong, reaching nearly or quite to the apex; upper leaf cells rather irregularly rounded, isodiametric, 7-10 μ in diameter, very dense above, papillose-mammillose, *with the papillae nearly as large as the cell* and sometimes slightly notched; lower cells becoming gradually elongated and smooth toward the base, oblong-rectangular at insertion. Dioicous; calyptra naked or nearly so; capsules nearly or quite immersed, oblong-ovoid, with a short broad neck, and very short seta, obscurely ribbed when dry, ± 1 mm. long; exothecial cells not differentiated; stomata superficial on the neck; operculum hemispheric-apiculate; peristome teeth 16, irregularly substriate, segments "8," *broader than the teeth and nearly as long*, punctate, composed of a double row of cells; spores in spring. Type locality, base of trees, Santee Canal, S. Carolina, Ravenell.

ILLUSTRATIONS:—Sull. *Icones Musc. 55. pl. 35*; *Pl. 51*.

Very rare. Norfolk, Virginia (James); Georgia, 1850 (Lesq.).

Sullivant says the teeth are 16 and segments 8, in the *Icones* he represents the segments alternate with the teeth.

21. ORTHOTRICHUM RIVULARE Turn. *Musc. Hibern. 96. pl. 8. 1804.*

Plants blackish green, aquatic, in floating or submerged tufts; stems 2-4 cm. long, sparingly branched above; leaves rather loosely imbricate when dry, ± 3 mm. long, decurrent, *oblong-lingulate, obtuse, in many cases irregularly toothed at apex; margins revolute to near apex*; costa strong, ending shortly below apex; leaf cells, except at base, papillose on both sides with low simple papillae; the upper rounded, rather irregular, nearly isodiametric, 10-12 μ in diameter, basal rectangular. Autoicous; capsules immersed to emergent, 8-ribbed, contracted below the mouth when dry and empty, when moist oblong-ovoid to ovoid; urn ± 2 mm. long with a short neck and seta (sometimes abruptly contracted to the seta), dark red at mouth; operculum conic-apiculate; exothecial cells of ribs well differentiated; annulus present; stomata immersed, near base of capsule; calyptra naked, deeply plicate; peristome double, the 16 teeth in pairs, recurved when dry, papillose with papillae tending to fuse into irregular groups; segments slender, 16, 8 about the length of the teeth, the alternating shorter, smooth, more or less appendiculate; spores 15-18 μ , maturing in spring. Type locality European.

ILLUSTRATIONS:—Bry. Eur. *pl. 219*; Braithw. *Brit. Moss Fl. 2: pl. 57B*; Husnot, *Musc. Gall. pl. 48*; *Pl. 50B*.

EXSICCATI:—Leiberg, *Plants of California No. 5424* (as *O. euryphyllum* Vent.).

On rocks, occasionally on wood or bases of trees. Apparently frequent in parts of California; Oregon, Washington, Idaho. A most interesting species, reminding one of *Grimmia alpicola rivularis* in macroscopic appearance.

22. ORTHOTRICHUM SPRUCEI Mont. *Spruce, Lond. Journ. Bot. 1845: 186.*

Loosely cespitose, 2-3 cm. high, dark green, stem erect, branching, upper leaves *lingulate*, 3.5-4 mm. long, 1-1.5 mm. broad, lower smaller, lanceolate from a broadly ovate base, *apex roundish, entire, or obtuse*

and slightly toothed or apiculate; margin revolute at base, sometimes *recurved above*; *costa ending far below apex*; upper cells rounded-hexagonal, 12–16 μ diameter, walls scarcely thickened, reddish, papillae single, minute, or wanting; basal short-rectangular to quadrate; perichaetial leaves subacute, costate nearly to apex, margins much less revolute. Autoicous; capsule immersed, thick, obovoid, when dry constricted under the mouth, deeply ribbed to the middle, striae 8, broad, of 4–6 rows of cells; neck short, abruptly narrowed into the pedicel; operculum conic-rostellate, red-margined; annulus double or triple; stomata immersed, mostly in the neck of the capsule; peristome double, teeth 16, colored, sometimes approximate in pairs, when dry radially spreading, each interruptedly cleft almost to the base in the middle line, with papillae minute and arranged more or less in lines; cilia 16, eight robust, equaling teeth in length, papillose below, the intermediate eight rudimentary or abortive. Type locality, English.

ILLUSTRATIONS:—Bry. Eur. *pl.* 214; Braithw. l. c. *pl.* 57C; *Pl.* 51.

EXSICCATI:—Holzinger, Musci Acro. Bor. Am. 571. "On rocks in a brook tributary to the Klickitat River, near Lyle, Washington, alt. 1000 ft. (Bailey).

This is the only American specimen seen that could be referred to this species. It was issued as *O. euryphyllum* but is intermediate between the two species. The peristome teeth are much shorter than in *euryphyllum* and lack the outside plates. The English type has the leaf margins less recurved above. Dr. Venturi identified as this species a plant collected by Leiberg "on willows overhanging the old channel of Clark's Fork of the Columbia River—Sept. 14, 1889."* *O. Sprucei* strongly resembles *O. rivulare* and is found in similar habitats but is usually found on wood and the leaves are broadest near the middle and are entire except for an occasional apiculus; the upper leaf cells are larger, reaching 20 μ in diameter; capsules immersed with a longer neck.

23. ORTHOTRICHUM EURYPHYLLUM Vent. Bot. Centralbl. 44: 417. 1890.

Loosely cespitose, 2–3 cm. high, dark green, stem erect, branching; upper leaves 3.5 mm. long, 1–1.5 mm. broad, lower smaller, lanceolate from a broadly ovate base, apex roundish, entire, or obtuse and slightly toothed, margin revolute nearly to apex, so that apex is sometimes inversely cucullate; *costa ending far below apex*; cells hexagonal, 12–16 μ in diam., walls not thickened, reddish, papillae single, minute or wanting. Autoicous; calyptra naked, plicate; seta short; capsule immersed, thick, broadly ovate, when dry constricted under the mouth, deeply sulcate to the middle, striae 8, broad, of 4–6 rows of cells; operculum conic-apiculate; column short, abruptly narrowed into the pedicel; annulus double or triple; stomata immersed, almost covered by bordering cells; peristome double, teeth 16, reddish, approximate in pairs, when dry radially spreading, *each interruptedly cleft almost to the base in the middle line*, papillae minute, and arranged in more or less regular lines; cilia 16, eight robust, equaling teeth, papillose below, the intermediate eight rudimentary or abortive; spores 16–19 μ . (Translated from the original.) Type locality, on stones, Ellensburg, Washington. *Pl.* 50A.

The basal leaf cells *turgid, almost inflated*, parenchymatous; peristome *teeth very long, about 0.5 mm., and slender with interrupted additional plates at the back*. The stomata are in the capsule neck; operculate capsules about 2 mm. long; operculum apiculus longer than the radius of the red margin of operculum. Type seen; growing on stones in rivulet. Ellensburg is near Thorp.

Venturi (Hedwigia 32: 268. 1893) compares *euryphyllum* with *rivulare* but it is much closer to *Sprucei*, having the upper leaf cells about 12 μ in diameter.

24. ORTHOTRICHUM ANOMALUM Hedw. Sp. Musc. 162. 1801.

Orthotrichum canadense Br. & Sch. London Journ. Bot. 2: 667. 1843. !

In rather dense mats or tufts, dark green to almost black, rather rigid, 1–2 cm. high, sparingly branched; leaves closely imbricate when dry, ovate- to oblong-lanceolate, 1.7–2.5 mm. long, rather abruptly acute to narrowly obtuse at apex; margin entire, strongly revolute; costa strong, reaching nearly to apex; basal cells rectangular, usually hyaline, often thin-walled, smooth; upper cells rounded-hexagonal, incrassate, papillose, about 10–15 μ in diameter, *in a single layer*. Autoicous; calyptra moderately hairy; capsules faintly ribbed just after operculum falls, ovoid to ovoid-cylindric moist, when very old somewhat narrowed below the mouth, *cylindric when thoroughly dry and empty*, tapering rather sharply at base, usually quite exserted (the perichaetial leaves sometimes reaching base of capsule when moist), *with 8 plain ribs*

* A specimen in the N. Y. Botanical Garden bearing a label identical with that of the plant identified as *O. Sprucei* by Dr. Venturi is surely not that species but *O. rivulare*.

and often 8 less distinct intermediate; operculum conic-rostrate; urn 1.5-2 mm. long; annulus present; exothelial cells very distinctly differentiated along the principal ribs; stomata immersed; peristome teeth 16, more or less grouped in pairs, marked with faint sinuous lines, irregular in height and direction, typically with a short preperistome in front of the 2-3 basal segments of the tooth (hard to demonstrate in most American plants); segments rudimentary or absent, occasionally nearly as long as the teeth, but very slender and fragile; spores maturing in early spring. Type locality, European.

ILLUSTRATIONS:—Bry. Eur. *pl.* 210; Braithw. Brit. Moss Fl. 2: *pl.* 57A; M. H. M. f. 86; Limpr. Laubm. f. 216.

EXSICCATI:—Sull. & Lesq. Musc. Bor. Am. (Ed. 1) 119; Aust. Musc. Appal. 160; Holzinger, Musc. Acro. Bor. Am. 64, 64a; Grout Musci Perfecti. 173.

On stones, chiefly calcareous; northern U. S. and Canada, south to New Mexico, west to Rocky Mts.; Dawson, Yukon Terr. Common in limestone regions in the N. Eastern U. S. In Europe this species frequents siliceous rocks, but in N. America it is much more abundant in limestone regions. Externally it resembles *Uloa americana*, but that is darker in color, has a more exserted capsule with a much more slender neck, and superficial stomata; peristome teeth papillose and reflexed when dry; leaf bases also much more colored.

24a. Var. *SAXATILE* (Schimp.) Milde, Bryol. Sil. 171. 1869.

Orthotrichum saxatile Schimp. Bry. Eur. Suppl. fasc. 1-2, *pl.* 210. 1864.

Seta usually longer; capsule narrowly cylindrical when dry, 8-striate; peristome teeth more united in pairs; segments fairly well developed, linear. Sull. & Lesq. Musc. Bor. Am. of both editions (119, 177) from Niagara Falls, seem to be this variety. Washington (Sandberg & Leiberg 870). R. S. Williams collected at Dawson, Yukon Terr. a form with capsules of *O. saxatile*, but with some very broad leaves, ovate at base; New Mexico (Wootton 3762 in part).

Drummond's 151, which was given as the type of *O. canadense* Br. & Sch. is most certainly a form of *O. anomalum*, at least in so far as the specimens in the set of the N. Y. Botanical Garden is concerned.

Orthotrichum Venturi Kindb. in Macoun Cat. Can. Pl. 7: 233, 1902, is a *nomen nudum* and is given by Paris as a variety of *O. anomalum* found growing on cedar rails. In any case the name is preoccupied by *O. Venturi* DeNot. Epil. 305. 1869.

25. *ORTHOTRICHUM CUPULATUM* (Hoffm.) Brid. Musc. Recent. 2^o: 25. 1801.

Closely resembling *O. anomalum* in gametophyte characters but leaves sometimes broadly ovate-lanceolate and blunt at apex; leaf margins less revolute as a rule; leaf papillae sometimes salient and forked. Autoicous; calyptra broadly campanulate, straw yellow when dry, sparsely hairy; capsule more or less emergent, rarely almost exserted, subglobose to obovoid, abruptly narrowed to a short seta (less than 1 mm. long) when dry oblong-cylindric, becoming urceolate with age, 1.5 mm. long, strongly 8-ribbed with 8 less conspicuous intermediate ribs; exothelial cells differentiated; stomata immersed, about the middle of the capsule; peristome simple or with rudiments of segments, teeth often with a distinct preperistome, spreading when dry, striate with fine sinuous lines; annulus present; operculum conic-rostellate; spores in summer. Type locality, Germany.

ILLUSTRATIONS:—Bry. Eur. *pl.* 209; Braithw. Brit. Moss Fl. 2: *pl.* 56E; Husnot, Musc. Gall. *pl.* 44; Pl. 53A.

On stones and ledges, especially those containing lime; rare in most parts of N. America and apparently confined to the western U. S. and western Canada. Idaho, Oregon, British Columbia; Polo, Pinto Co., Texas (Isely); common in Utah (Flowers).

25a. Var. *NUDUM* (Dicks.) Braithw. l. c. 78.

Orthotrichum nudum Dicks. Crypt. fasc. IV: 7. *pl.* 19, f. 13. 1801.

Orthotrichum Rudolphianum Lehm. Flora, 44: 656. 1827.

Tufts wider, looser, deep green; capsule almost exserted, with a longer tapering neck; peristome teeth more strongly striolate, with a much more fully developed preperistome; calyptra nearly hairless.

Specimens from Great Falls, Montana (Williams, no. 59) and from* Lake Pend d'Oreille, Idaho (Leiberg, 185, on granite) have been determined as *O. nudum Rudolphianum* (Lehm.) Schimp. Drummond's

* A specimen thus labeled (except no. 185) in U. S. Nat. Museum is *O. cupulatum*.

152 from Niagara Falls is this variety though far out of its usual range. The lines on the peristome teeth of American *O. cupulatum* are rarely as distinct as in the European form, often tending to become rows of joint papillae as in *O. strangulatum*.

Flowers in his Utah collections finds the peristome teeth in some specimens spreading to recurved and the segments lacking to well developed, apparently intermediate forms grading into *O. Hallii*. Also he finds variation in the amount of bistratose tissue in the upper part of the leaves.

26. ORTHOTRICHUM URNIGERUM Myrin, Coroll. Fl. Upsal. 71. 1834.

Differs from *O. cupulatum* in the acute to slenderly acuminate leaves, strongly papillose with large salient papillae; peristome double with 8-16 well developed segments; teeth with large irregular papillae at base, striate above. Bry. Eur. pl. 222.

This rare European species was identified by Venturi from Röhl's collections, Yellowstone National Park, Wyoming. Not reported elsewhere from N. America. Occurrence considered doubtful.

27. ORTHOTRICHUM STRANGULATUM Schwaegr. Suppl. 1²: 33. pl. 54. 1816. (not of Sullivan).
Doubtfully of P. B. Prod. 81. 1805.

Orthotrichum parvulum Mitt. Journ. Linn. Soc. 8: 25. 1865.

Orthotrichum Porteri Aust. Musc. Appal. 161. 1870.

Orthotrichum Peckii Aust. l. c. 162.

Orthotrichum cupulatum var. *Porteri* Sull. Icones Musc. Suppl. 61. 1874.

Orthotrichum cupulatum parvulum Lesq. & James, Manual 16. 1884.

Plants in dense thin mats, very dark, almost black except the young tips, 1 cm. or less in height; upper and perichaetial leaves often slenderly acute but otherwise hardly to be distinguished from those of *O. anomalum*; some of the lower leaves are nearly plane-margined and obtuse, often bistratose on the margins above; basal cells rather shorter than in *anomalum*, short-rectangular to quadrate and upper cells papillose with low simple papillae as a rule; costa occasionally percurrent. Autoicous; calyptra hairy with papillose hairs; capsules typically subcylindric, about $\frac{1}{2}$ emergent when dry but sometimes immersed when moist and oblong-cylindric, about 1.5 mm. long, tapering to a seta about 0.5 mm. long, 8-ribbed; operculum conic-rostellate; annulus present; peristome usually simple, of 16 teeth, often somewhat paired, erect to spreading, papillose, papillae often joined in vague lines forming irregular branched ridges; occasionally narrowly linear segments present; exothelial cells differentiated; stomata immersed, about the middle of the capsule; spores in spring. Type locality, Pennsylvania (Muhlenberg).

ILLUSTRATIONS:—Jennings, Mosses Western Pa. pl. 14; Pl. 53B.

EXSICCATI:—Austin, l. c.; Holzinger, Musc. Acro. Bor. Am. 65; Grout, Musci Perfecti, 215; Sull. & Lesq. Musc. Bor. Am. (Ed. 1) 117 (as *O. Sturmii*).

On limestone; Vermont, Utah, Alabama, Pennsylvania to Minnesota, south to Missouri, Tennessee and Kentucky. The papillose peristome teeth and the differently shaped capsule indicate that this is sufficiently distinct from *O. cupulatum*. Mrs. Britton (Bull. Torr. Bot. Club, 21: 2-3) seems to have established that *O. strangulatum* Schwaegr. is identical with *O. Porteri* Aust. and probably with the same of P. B.

The eastern forms seem to have bistratose margins and frequent bistratose streaks, while those west of the Mississippi seem to be consistently unistratose throughout.

27a. Var. MISSOURICUM Holzinger n. var.

Orthotrichum missouricum Holzinger Ms.

Margines foliae crassae e cellulis 4-5-seriatis constructae.

Leaf margins thickened, of five or more layers of cells. Sporophytes unknown.

Near Clayton, Missouri, P. M. Lawrence, April 1904. Type in herb. New York Botanical Garden.

28. ORTHOTRICHUM LESCURIi Aust. l. c. 163.

Leaves more slenderly lanceolate than in the last; capsule immersed, more abruptly contracted to the seta, globose-obovoid when moist, with urn usually less than 1.5 mm. long; peristome teeth 16, more or less grouped in pairs, slender, more finely and faintly papillose, more or less open along the divisural line; stomata fewer. Type locality, Northern New Jersey.

ILLUSTRATIONS:—Sull. l. c.; Jennings, l. c. *pl.* 15; *Pl.* 53C.

EXSICCATI:—Aust. l. c.

On limestone; sometimes on granite or trap; "New England to Ontario, south to Pennsylvania and Missouri and in the Rocky Mts. to British Columbia" (Jennings, l. c. 119).

Capsules much like those of *cupulatum* but peristome teeth very different.

29. *ORTHOTRICHUM HALLII* Sull. & Lesq., Sull. Icones Musc. Suppl. 63. *pl.* 45. 1874.

Orthotrichum leiodon Kindb. Hedwigia (Beiblatt) 42: Suppl. 1: 17. 1903.

Plants dark green, in rather dense wide tufts; stems \pm 1 cm. in length, branching above; leaves loosely imbricate and somewhat contorted when dry, elongate-lanceolate, narrowly obtuse, keeled, costate to near the apex, *bistratose above*, papillose with stout simple papillae except at base; *margins revolute about half way to apex*, in some upper and perichaetial leaves nearly to apex; basal leaf cells rectangular, about 12 μ wide, 2-3 : 1, thin-walled and pellucid; upper cells dense, rounded-hexagonal, 10-12 μ in diameter. Monoicous; calyptra hairy; capsule immersed when wet, obovoid, 1.5-2 mm. long, on a short seta (1 mm. or less), 8-ribbed when empty; annulus present; stomata immersed; exothecial cells rather thin-walled and soft, differentiated along the ribs, at the capsule mouth about 6-12 rows of thick-walled, round or transversely elongated cells; peristome double, with linear fugacious segments; teeth 16, paired, *erect until very old, vermicular-striate throughout*; operculum mammillate-rostellate; spores in summer. Type locality, "on trees," Rocky Mts. of Colorado (Elihu Hall). All subsequent collections have been from rocks and it is probable that the original label is in error.

ILLUSTRATIONS:—Sull. l. c.; Bryol. 5: *pl.* 5. *Pl.* 54.

EXSICCATI:—Holzinger, Musc. Acro. Bor. Am. 90, 90a.

Apparently not rare in the Rocky Mts. in New Mexico, Colorado, and Wyoming, at altitude 6,000-10,000 ft. Reported from Hector, Rocky Mts. by Macoun.

Nearer to *O. cupulatum* than has been realized, distinguished by the more elongated capsule, presence of segments, more finely striate teeth and the leaves bistratose above. The teeth as a rule are broader and more closely paired. A specimen of *O. cupulatum* from Wales, from the herbarium of Wilson, has the teeth almost as striate as in *O. Hallii*. Forms appearing to be *cupulatum* or *Hallii* in other respects are occasionally found with papillose peristome teeth. American *cupulatum* frequently has bistratose streaks above.

30. *ORTHOTRICHUM ALPESTRE* Hornsch. Bry. Eur. *pl.* 213. 1849.

Orthotrichum stramineum Bry. Eur. fasc. 1-2. 1837 (in part only).

Plants in rather dense bright to dark green tufts or mats, 1-2 cm. high; leaves loosely imbricate and more or less contorted when dry, lanceolate to ovate-lanceolate, *acute or sometimes apiculate* at apex, about 3 mm. long, keeled; margins strongly revolute except at base; basal cells smooth, rectangular, rather thin walled and clear or brownish; upper cells rounded-hexagonal, 10-12 μ in diameter, *bearing large simple or forked papillae*; costa disappearing in the apex. Monoicous; calyptra with a few hairs; capsules more or less emergent on a short (0.5 mm.) seta (seta and capsule rarely shorter than the perichaetial leaves when moist), obovoid to pyriform, with a distinct neck, 8-ribbed when dry, about 1.2-2 mm. long; subcylindric and strangulate when old and dry; stomata immersed; operculum conic-apiculate; exothecial cells differentiated along the ribs, thinner-walled and more transparent than in most species; peristome double, teeth 16, united in pairs at first, sometimes more or less perforate above, finely papillose, *the papillae on the lower part of the teeth separate or in faint irregular designs, in the upper part in faint vertical lines and lighter colored than below*; segments linear, 8, nearly as long as the teeth, of two rows of cells below, smooth; spores in summer. Type locality, European ("Kärnathen").

ILLUSTRATIONS:—Bry. Eur. *pl.* 213; Husnot, Musc. Gall. *pl.* 50; Limpr. Laubm. 2: 70, f. 230; *Pl.* 51.

EXSICCATI:—Drumm. Musc. Am. 149! !

On rocks, preferring dolomite and limestone; occasionally on trees; Rocky Mts., Colorado and Utah to the Yukon, at relatively high altitudes and latitudes; apparently more frequent in Colorado and Utah; Mt. Whitney, California.

30a. Var. *OCCIDENTALE* (James) n. comb.

Orthotrichum occidentale James, Bot. King Exped. 402. 1871.

Orthotrichum alpestre, var. Sull. Icones Musc. Suppl. 69. *pl.* 51. 1874.

Orthotrichum alpestre var. *majus* Lesq. & James, Manual 169. 1884.

"More robust, glaucous green; leaves broader; . . . cells with longer, simple or double papillae; teeth longer, entire, minutely punctate."

Not always more robust, but peristome finely papillose above and papillae not in lines. The pattern made by the papillae in the upper portion of the peristome of *O. alpestre* is not as fixed in North America as in Europe. Vague patterns in the lower part of the teeth are not rare. The type of *O. occidentale* has been seen.

30b. Var. *WATSONI* (James) n. comb.

Orthotrichum Watsoni James l. c. 491 & Sull. l. c. 73. *pl.* 54.

Very robust, leaves reaching 4 mm. in length, light green; "capsules with a distinct neck;"* perichaetial leaves longer than seta and capsule on account of short seta; peristome teeth nearly smooth above. Nevada, Watson. Sterile plants of the type collection have been seen.

The somewhat contorted leaves of *O. alpestre* sometimes simulate the appearance of the *Pulchella* group, but such plants are stouter and occasional plants have some leaves as apiculate as in *O. pumilum*, but the very large papillae and the characteristic peristome teeth are pretty sure marks of distinction. These teeth are often erect long after dehiscence. Flowers' plants from Utah often bear septate gemmae.

31. *ORTHOTRICHUM JAMESIANUM* Sull. Bot. King's Exped. 491. 1871.

Plants in dense thin tufts or cushions, pale green above; stems reaching 1 cm. in height, little branched; leaves oblong to oblong-lanceolate, reaching 2 mm. or more in length, broadly or narrowly obtuse, with revolute margins, densely papillose, except at base, with narrow salient papillae, which may be simple or furcate, nearly opaque above; upper leaf cells rounded-hexagonal, indistinct, about 12 μ in diameter; median basal cells oblong-rectangular, 2-3 : 1; marginal smaller and shorter; costa stout, ending just below the apex, scarcely attenuate. Monoicous; calyptra with a few papillose hairs; capsule immersed to slightly emergent, pyriform with a short neck and a slightly longer seta, when dry 8-ribbed and constricted below the mouth, urn \pm 1 mm. long; annulus persistent, below it 6-8 rows of small incrassate cells; exothelial cells differentiated along the ribs; stomata immersed, nearly hidden; peristome single, teeth reflexed, 16, striate; spores papillose. Type locality, on limestone rocks, East Humboldt Mts., Nevada, alt. 7,500 ft. (Watson). Also in British Columbia, Macoun, Can. Musci 129; Banff, Alberta and Pipestone Pass, Alberta, Can. Mosses 107a (as *O. consimile*). Cotype in the U. S. National Museum seen and studied.

ILLUSTRATIONS:—Sull. Icones Musc. Suppl. *pl.* 53; *Pl.* 54.

Easily distinguished from *O. obtusifolium* by the much stouter costa, revolute leaf margins and immersed stomata.

32. *ORTHOTRICHUM TENELLUM* Bruch; Brid. Bryol. Univ. 1: 786. 1827.

Plants in small, short, deep green cushions \pm 1 cm. high; leaves rather loosely imbricate when dry, 2 mm. or more long, multiform on the same plant, rounded and obtuse at apex (or infrequently acute) linguulate-lanceolate to oblong-lanceolate, concave; margins recurved to apex; costa ending below apex, which is rarely slightly serrulate; upper cells irregular, rounded-hexagonal, incrassate, nearly isodiametric, 10-12 μ in diameter, more or less papillose; basal cells rectangular to quadrate on the margins, more elongated near the costa, smooth, mostly hyaline. Autoicous; seta less than 1 mm. long; capsule more or less emergent, oblong-cylindric to shortly cylindric when moist, with neck about as long as the seta, when dry narrowly cylindrical, deeply 8-ribbed for the whole length, little or not at all contracted under the mouth when dry, about 1.5-2 mm. long; operculum apiculate; calyptra long-conic, covering the spore sac, sparsely hairy; annulus present; exothelial cells strongly differentiated; stomata on the neck near base of spore sac, immersed, nearly covered by the overlapping cells; peristome double, the teeth 16, united in pairs, papillose, reflexed when dry; segments linear, shorter than the teeth; vaginula glabrous; spores in spring. Type locality, Germany.

ILLUSTRATIONS:—Bry. Eur. *pl.* 212; Husnot, Musc. Gall. *pl.* 50; Braithw. Brit. Moss. Fl. *pl.* 58B; *Pl.* 51.

* Mrs. Britton in a note at the New York Botanical Garden.

EXSICCATI:—Heller, Plants of California 6470 (as *O. brachytrichum*); Holzinger, Musc. Acro. Bor. Am. 593 (as *O. consimile*); Utah (Flowers).

On bark of trees, California and Rocky Mt. region, New Mexico to Alberta. The description in the Lesq. & James Manual is misleading in many particulars and European authors do not agree. The leaves are very concave at the blunt apices.

Flowers' plants have slightly serrulate leaves, spreading peristome teeth and naked calyptra.

33. **ORTHOTRICHUM CYLINDROCARPUM* Lesq. Trans. Am. Phil. Soc. 13: 6. 1863.

Orthotrichum Coulteri Mitt. Journ. Linn. Soc. 8: 25. 1865.

After a careful study of authentic material only the following differences between this and the last seem to be constant. *O. cylindrocarpum* has the leaves a little less concave at apex, which is rather narrower also and the capsules are almost entirely above the perichaetial leaves even when moist. Probably better a variety than even a subspecies. Type from California (Bolander).

ILLUSTRATIONS:—Sull. Icones Musc. Suppl. pl. 52; Pl. 52.

EXSICCATI:—Bolander's collections from California named by Lesq. and probably co-types; Howe, no. 32, Berkeley, Calif.; Baker, Pacific Slope Bryophytes, 340; Heller, Plants of California, 5090; Sull. & Lesq. Musc. Bor. Am. (Ed. 2) 178 (the type); R. & C. Musc. Am. Sept. 219.

34. *ORTHOTRICHUM BARTRAMI* Williams, Bryol. 28: 76. pl. 9. 1925.

"Dioicous or autoicous, male flowers 2 or 3 together on separate plants or single on short branches a little below the perichaetium, of 10 to 12 antheridia, without paraphyses, the inner perigonal leaves rotund, scarcely three-fourths mm. high, mostly costate, pale, the apex obtuse or acute and not quite entire: plants in low, rather compact cushions on bark; the mostly reclining stems, radiculose at base, about 1 cm. high, will often one or two branches; upper stem-leaves 2–2.5 mm. long, oblong-ovate, acutely or obtusely pointed, slightly dentate and with borders often incurved at the apex, just below becoming recurved on the borders to near base; the leaves when dry erect and appressed, when moist widely spreading; costa not quite percurrent; leaf-cells distinct, round or oblong with thickened walls and mostly two small papillae to each cell-surface in upper part of leaf, the median cells 8 by 8 μ to 8 by 12 μ , the basal cells pale, rectangular, smooth, up to 50 or 60 μ long by 12 μ wide toward the costa and extending about one-fourth way up the leaf; perichaetial leaves very similar to those of upper stem, with rectangular cells extending higher up; capsule emergent, about 1.5 mm. long, slightly obovate when moist, when dry more or less cylindric, with eight ribs and contracted under the mouth, on a seta about 1 mm. long; stomata immersed, scattered over the tapering neck; peristome finely papillose throughout, of 16 teeth in pairs and 8 slender cilia (segments), the teeth when dry strongly reflexed after the falling of lid; lid convex-apiculate; annulus persistent, of two or three rows of nearly square cells; calyptra more or less hairy, eight-striate, nearly entire at the base; spores finely papillose, about 16 μ in diameter.

"On bark of oaks, Whitehouse Canyon, Santa Rita Mts., Arizona, at 6000 ft., E. B. Bartram, no. 1465, Feb. 11, 1925, and no. 27, at 5000 ft., Dec., 1922.

"This plant seems most closely related to *O. tenellum* Bruch, but the leaves are broader in the upper part, the cells much more distinct and rounded, with very small distinct papillae, the cilia more slender and the perigonal leaves much broader."

ILLUSTRATIONS:—Bryol. l. c.; Pl. 52.

EXSICCATI:—Holzinger Musc. Acro. Bor. Am. 570 (as *O. Douglasii*) and Bartram, Mosses S. Arizona No. 27 (as *O. cylindrocarpum*), also no. 153; Grout, Musci Perfecti. 172.

Leaves frequently acute or serrulate at apex. Very striking is the peculiar appearance of many of the leaf apices as if pinched together at the apex. The leaf cells are more rounded than in *O. tenellum* but scarcely more distinct.

35. *ORTHOTRICHUM PALLENS* Bruch, in Brid. Bryol. Univ. 1: 788. 1827.

Very close to *O. tenellum*; upper leaves rounded and often crenulate with projecting cells at apex, the others various; upper leaf cells reaching about 12 μ . Antheridia on a short special branch; calyptra conic-campanulate, naked; stomata only slightly covered by the surrounding cells, often seemingly almost superficial, situated at or near the middle of the spore sac. Differs from *O. pumilum* Dicks. in the rather smaller leaf cells, having much thicker walls, more lingulate upper leaves; bearing antheridia on a special branch; capsule with a longer and narrower neck.

Credited to North America by Mitten from specimens collected on the Pack River, British Columbia, by Lyall. I have seen the Pack River plants. They are yellowish; the stomata are more nearly covered; capsules oblong when dry and only about $\frac{2}{3}$ the length of the usual European form. In spite of the fact that the antheridia are on a more specialized branch than usual, I think the Pack River specimens are only a form of *O. tenellum*.

Var. *PARVUM* Vent. Hedwigia 12: 21. 1873 is reported as collected by Roell in Yellowstone National Park (Hedwigia 32: 284. 1873). I have not seen these specimens but a quite distinct plant which is apparently this variety has been collected by Flowers in at least two localities in Utah. The leaves are obtuse and mostly crenulate at apex by projecting cells; seta and capsule less than 2 mm. long; capsule short obovoid.

This form is distinguished from *O. rivulare* by the smaller size, dryer habitat, leaves narrower in the upper part and the more exposed stomata. Pl. 55.

36. ORTHOTRICHUM STELLATUM Brid. Bryol. Univ. 1: 274-275. 1826.

Orthotrichum strangulatum Sull. Mosses U. S. 33. 1856. (not of P. B. or Schwaegr., nor of Bridel?).

Orthotrichum Braunii Bry. Eur. fasc. 2-3, pl. 215. 1837.

Plants in small dense cushions reaching 1 cm. in height, branched above; leaves appressed-imbricate when dry, broadly lanceolate, subacute to obtuse, keeled, ± 2 mm. long, papillose except at base; margins revolute, sometimes nearly to base and apex at others only in the middle; costa ending just below apex; upper leaf cells irregular, rounded, incrassate, isodiametric to slightly elongated, 10-13 μ in diameter; basal cells quadrate to short-rectangular, with more or less rounded corners. Autoicous; calyptra plicate, naked; capsule obovoid-pyriform, immersed to emergent, much longer than the very short seta to which it is rather abruptly contracted, 1-1.5 mm. long, when dry and empty strongly 8-ribbed, *dark colored and strongly contracted below the mouth*; annulus present; exothecial cells differentiated along the ribs; several rows of small incrassate cells below annulus; stomata immersed; operculum conic-apiculate; peristome teeth 16, united in pairs, reflexed when dry, pale yellow, finely papillose, not perforate at apex; segments narrowly linear, of 1-2 rows of cells, shorter than the teeth; spores 10-13 μ in diameter, maturing in late spring.* Type locality, S. Deerfield, Mass.

ILLUSTRATIONS:—Sull. Icones pl. 36 & Suppl. pl. 47; Husnot, Musc. Gall. pl. 49; Limpr. Laubm. 2: f. 232; M. H. M. f. 88.

EXSICCATI:—Drumm. Musc. Am. 150 in part (as *O. affine pumilum*, Det. E. G. B.); Austin, Musc. Appal. 150 & 167?; Sull. & Lesq. Musc. Bor. Am. (Ed. 1) 120, (Ed. 2) 179; Sull. Musc. Allegh. 128; Holz. Musc. Acro. Bor. Am. 469.

On trees in the open, especially apple and butternut; common in eastern Canada and northeastern U. S.; south to Georgia, west to Iowa.

Distinguished from *O. ohioense* and *O. sordidum* by the much darker and more strangulate capsules and hairless or nearly hairless calyptra; from *O. sordidum* by the much blunter leaves. Sullivant's figure of the dry capsule in the Supplement is much more like it as it occurs in New England.

37. ORTHOTRICHUM OHIOENSE Sull. & Lesq. Musc. Bor. Am. (Ed. 2) 181. 1865.

Orthotrichum canadense Sull. & Lesq. Musc. Bor. Am. (Ed. 1) 121. 1856 (not of Br. & Sch.).

Orthotrichum citrinum Aust. Musc. Appal. 170. 1870.

Plants in rather small dense cushions, light green above, brownish below; stems 5-10 mm. long, branching above; leaves oblong-lanceolate, appressed-imbricate when dry, narrowly obtuse to obtusely acute, 1.7-3 mm. long; margins entire, revolute; costa strong, ending a little below the apex; upper leaf cells irregularly rounded, incrassate, nearly isodiametric, 10-12 μ papillose, becoming elongated toward the base, at base smooth, rectangular near costa, quadrate at margins. Autoicous; calyptra somewhat hairy, campanulate; capsules reaching about to the tips of perichaetial leaves when moist, 1-1.3 mm. long, longer than the seta, oblong-ovoid, *when dry and empty straw-colored* and somewhat 8-ribbed *and slightly or not at all contracted under the mouth*; neck short or almost lacking; annulus narrow; 3-5 rows of upper exothecial cells incrassate rounded, only the upper transversely elongated, below these differentiated along the ribs; stomata immersed, a little below the middle of the capsule; operculum convex-apiculate; peristome

* See Bryol. 28: 71.

teeth 16, more or less united in pairs, densely and finely papillose, occasionally perforate at tips, reflexed when dry; segments linear, of two rows of cells, shorter than the teeth; spores 18–21 μ , papillose; maturing in early spring. Type locality, Ohio.

ILLUSTRATIONS:—Sull. *Icones Musc. Suppl. pl. 48*; Jennings, *Mosses Western Pa. pl. 15*; M. H. M. f. 87. EXSICCATI:—Sull. & Lesq. l. c. & (Ed. 2) 181; Aust. l. c. & 169.

On bark of trees in rather open places; southeastern Canada and eastern U. S.; south to Florida, west to Ontario, Ohio and (according to Jennings) Montana.

In general appearance much resembling *O. sordidum*, but a little smaller and distinguished by blunt leaves and immersed stomata. *O. stellatum* has a nearly or quite smooth calyptra and capsule darker and much more contracted under the mouth when dry.

38. *ORTHOTRICHUM PUMILUM* Dicks. Pl. Crypt. fasc. 4: 5. 1801.

Orthotrichum affine var. *pumilum* Hook. & Tayl. *Musc. Brit.* 74. 1818.

Orthotrichum Schamperi Hamm. *Mon. Orthot. Suec.* 9. 1852.

Orthotrichum fallax Schimp. *Syn.* (Ed. 1) 264. 1860.

Orthotrichum brachytrichum Schimp. *Proc. Am. Acad.* 14: 140. 1879.

Orthotrichum fallax var. *truncatulum* Aust. *Bull. Torr. Bot. Club.* 6: 344. 1879.

Orthotrichum inflexum C. Muell. *Syn.* 1: 690. 1849.

Plants in short (1 cm. or less) close dark green tufts; leaves broadly to narrowly oblong-lanceolate, acute to narrowly obtuse, often apiculate with usually a single subhyaline cell at apex, \pm 2 mm. long, imbricate when dry, not contorted; margins revolute nearly to apex; costa ending below apex; upper leaf cells larger and less dense than in most species, with thinner walls, slightly collenchymatous, 12–16 μ in diameter, irregularly rounded-hexagonal, papillose with low papillae; basal cells smooth, oblong-rectangular near the costa to quadrate on the margins. Autoicous; seta about 0.5 mm. long, together with the broad capsule neck sheathed in the ochrea; capsules usually light colored, immersed or slightly emergent, 1.5 mm. or less in length, oblong to oblong-ovoid, abruptly narrowed to the seta, when dry 8-ribbed and contracted below the mouth; annulus present; exothecial cells differentiated; stomata immersed, the guard cells sometimes nearly covered with the surrounding cells, at others nearly all visible, both forms seen on the same capsule; operculum conic-apiculate; calyptra strongly plicate, naked or usually with a few very short hairs near the apex; peristome double; teeth 16, usually united in pairs, finely papillose, reflexed when dry, rarely perforate above; segments 8, linear, shorter than the teeth, of two rows of cells at base, easily broken; spores in spring. Type locality European.

ILLUSTRATIONS:—Bry. Eur. pl. 211; Husnot, *Musc. Gall.* pl. 48; Braithw. *Brit. Moss Fl.* 2: 57E; M. H. M. f. 89.

EXSICCATI:—Holz. *Musc. Acro. Bor. Am.* 89, 381; Aust. *Musc. Appal.* 165. On bark of trees; south-eastern Canada, eastern U. S. east of the Rocky Mts., Idaho, Utah, south to Tennessee.

The calyptra in American plants seems to be more frequently furnished with short hairs than is the case in Europe.

38a. Var. *FALLAX* (Bruch) n. comb.

Orthotrichum pumilum Sw. *Disp. Musc. Suec.* 42: 92. pl. 4, f. 9. 1799 (not of Dicks. 1801).

Orthotrichum fallax Bruch, in *Brid. Bryol. Univ.* 1: 787. 1826.

Capsules emergent half way or more, light yellow, blackish when old, longer, oblong-cylindric with tapering neck, narrowly cylindric with flaring mouth when old. Montana (Williams, identified by Venturi); Idaho (Sandberg and others, *Plants of Northern Idaho No. 1142*) in the U. S. National Museum; Utah (Flowers no. 926 & 1864) and several other collections.

These American plants seem to agree with the European *O. pumilum* Sw. They are distinctly western and are recognizable when young by the light colored capsules, which seem almost exerted when dry.

39. *ORTHOTRICHUM GARRETTI* Grout & Flowers, n. sp.

Plantae atro-virides; folia late lanceolata, 2–2.7 mm. longa, acuta vel tenui-acuminata, interdum serrata, in apicem cellula hyalina et elongata terminata, margine revoluta; costa valida, infra apicem desiniente; cellulae mediae papillosae, 10–20 μ ; dentes peristomii 16, breves, papillosae 0.18 mm. longae;

processibus linearibus e cellularum duplici serie exstructis, dentes longitudine aequantibus, valde appendiculatis.

Plants in thin dark green cushions, 1 cm. high or less; leaves loosely imbricate and somewhat contorted when dry, broadly lanceolate, broadest a little above the base, concave with margins revolute nearly to apex, the upper reaching 2.7 mm. in length, *often bearing numerous septate brood bodies; apices slenderly acute to acuminate, often serrulate and tipped with one or more hyaline elongated cells*, very brittle and often broken off; costa strong, ending below the apex; upper leaf cells strongly papillose with rather broad low papillae, which may be sharp and salient near the apex, rounded and nearly isodiametric, *10–20 μ in diameter, with walls thin for the genus*, densely chlorophyllose; basal cells short oblong-rectangular, quadrate on the margins. Antheridia not seen; calyptra campanulate, bearing a few short hairs near apex; capsule emergent, short-oblong with a short neck about the length of the seta (0.5 mm.); capsule including the conic-apiculate operculum about 2 mm. long, 8-ribbed; stomata immersed; peristome teeth 16, short, about 0.18 mm. long, finely papillose, more or less united in pairs at first, often narrowly perforate above; segments of two rows of cells, nearly or quite as long as the teeth, rather sparingly papillose, *appendiculate with several very long processes reaching half way or more to the next segment*; spores in spring; *Pl. 55.*

Type from sandstone, Emma Park, Carbon Co., Utah, (Flowers no. 834), May 8, 1928.

The large leaf cells and apiculate apices remind one of *O. pumilum* Dicks., but the apices are much longer and often hyaline, while the peculiar long, appendiculate segments separate it from any allied forms. It is quite possible that this may be the *O. canum* of Mitten, Journ. Linn. Soc. 8: 26. 1865, but so far as the author can learn no specimen of this can be located.

40. ORTHOTRICHUM PUSILLUM Mitt. Journ. Linn. Soc. 8: 25. 1865.

Orthotrichum psilocarpum James, Trans. Am. Phil. Soc. 13: 110. 1869.

Plants blackish-green, small, 5 mm. high or less, in loose patches; upper leaves larger, broadly oblong-lanceolate to oblong-lingulate, narrowly to broadly obtuse, *some or all denticulate at apex*, 1.5–2.5 mm. long, keeled; margins strongly revolute; upper leaf cells irregularly rounded, incrassate, about 15 μ in diameter, papillose; basal shortly rectangular, 2–4 : 1, shorter on the margins. Monoicous; *calyptra plicate, naked; capsule immersed or nearly so, subglobose to ovoid*, short oblong when dry, *almost sessile on a very short seta, smooth*, occasionally slightly and irregularly wrinkled when very old and dry, not ever ribbed, *whitish*, urn about 1.6 mm. long; operculum convex-umbonate; annulus present; exothelial cells thin walled except a few rows at mouth, not often differentiated; stomata immersed, about the middle of the capsule; peristome teeth 16, *densely and coarsely papillose*, reflexed when dry; segments slender, short, easily broken, spores about 15 μ in diameter, maturing in early spring. Type locality, Pennsylvania.

ILLUSTRATIONS:—Sull. Icones Musc. Suppl. *pl. 50; M. H. M. f. 90.*

EXSICCATI:—Drumm. Musc. Am. S. States 82 (in part only, issued as *O. affine* var. *pumilum*); Sull. & Lesq. Musc. Bor. Am. (Ed. 2) 180; Aust. Musc. Appal. 171.

On bark of trees; New England to Florida, west to Illinois and Missouri. *O. pumilum* and *O. pusillum* are both minute, dark colored plants with nearly or quite naked calyptra, strongly papillose peristome teeth and large leaf cells and the leaves of both are occasionally somewhat denticulate at apex, rarely so in the former and frequently in the latter. *O. pumilum* has the capsule oblong, plainly ribbed and contracted below the mouth when dry, with exothelial cells plainly differentiated and peristome teeth closely united in pairs, while *O. pusillum* has capsules smooth or very slightly wrinkled when dry, shorter, subglobose, exothelial cells scarcely differentiated, and teeth soon separated, but these intergrade in various ways so that some specimens may be referred to either equally well. In general, *pumilum* has the more northern range.

41. ORTHOTRICHUM PULCHELLUM Brunton, Eng. Bot. *pl. 1787.* 1807.

Plants *yellowish- to olive-green*, in loose soft tufts, 1 cm. or less in height, leaves when dry flexuose to crispate, linear-lanceolate, 2.5–3 mm. long, *slenderly acute* at apex, occasional leaves ending in a short apiculus of 1–2 cells; margins revolute except near apex; costa ending below apex; upper cells incrassate, irregularly rounded, nearly isodiametric, faintly papillose, $\pm 10 \mu$ in diameter; basal smooth, quadrate on the margins, elongate near the costa, more incrassate than in most species. Autoicous, *capsules almost exerted*, (perichaetial leaves reaching a little above the capsule neck when moist) on a seta 1.5 mm. long, oblong-obovoid, contracted into a short neck, 8-ribbed the whole length when dry and scarcely contracted below the mouth; operculum short-rostrate; calyptra naked; annulus present; exothelial cells *strongly*

differentiated, 3-5 rows of small round incrassate cells below the annulus; stomata in one or more rows *from middle to upper part of spore sac*, immersed; peristome teeth 16, more or less united in pairs, later separate, *dark orange-red*, at first erect or spreading, later reflexed, papillose, with the papillae often arranged in indefinite lines, striate and somewhat split at the apex; segments 8-16, filiform; spores in spring. Type locality, Durham, England.

ILLUSTRATIONS:—Bry. Eur. *pl.* 223; Husnot, *Musc. Gall. pl.* 52; Braithw. *Brit. Moss Fl.* 2: *pl.* 58C; *Pl.* 52.

EXSICCATI:—On trees, west coast of N. America; Skeena River, B. C., Macoun; Baranoff Id., Sitka, Alaska, Harriman Exped. No. 2353. These are the only specimens seen that agree with the European *O. pulchellum*. The orange teeth easily distinguish it from all other American species.

41a. Var. COLUMBICUM (Mitt.) n. comb.

Orthotrichum columbicum Mitt. *Journ. Linn. Soc.* 8: 24. 1865.

Differs in the shorter seta, smaller immersed capsules and narrower leaves. In the specimens examined there were only 1-2 rows of small rounded cells below capsule mouth. Type on trees, Vancouver Id. (Lyll). Type seen.

EXSICCATI:—Holz. *Musc. Acro. Bor. Am.* 514, Granite Falls, Washington.

The red peristome teeth and slender leaves make this species and variety easy to recognize and more material will undoubtedly be uncovered in our herbaria. Most of the American material labelled *O. pulchellum* is *O. consimile*.

42. ORTHOTRICHUM CONSIMILE Mitt. *Journ. Linn. Soc.* 8: 24. 1865.

Orthotrichum ulotaforme R. & C. *Bot. Gaz.* 15: 42. *pl.* 7b. 1890. (Type seen.)

Orthotrichum pulchellum of the Lesq. & James Manual. 175. 1884 (not of Brunton).

Orthotrichum glabrum Vent. *Hedwigia* 32: 285. 1893.

Orthotrichum pulchellum longipes Sull. Lesq. & James, l. c.

Orthotrichum pulchellum leucodon Vent. *Bot. Centralbl.* 44: 419. 1890.

Orthotrichum Hendersoni R. & C. *Bot. Gaz.* 15: 42. 1890.

Orthotrichum pulchellum productipes R. & C. l. c. 43.

Plants looking like an *Ulota*, reaching 2.5 cm. in height, typically characterized by the *light yellow-green color and crispate leaves, long linear-lanceolate*, sometimes the plants are darker colored with leaves contorted but scarcely crisped when dry; leaves slenderly acuminate to bluntish, reaching 3 mm. in length; upper leaf cells markedly papillose. Autoicous; calyptra naked or with a few hairs; capsule almost exserted to long-exserted on a seta 4 mm. long, short-oblong, 8-ribbed to base, much shrunken when old, rather abruptly narrowed to the seta by a short neck, urn 1.5-2 mm. long; operculum conic-rostellate; annulus present; peristome teeth 16, pale, faintly papillose, with papillae often in faint patterns, united in pairs at first and erect, later separating and reflexed; segments well developed, narrowly linear, nearly or quite as long as the teeth, 8, or 16 in vigorous plants, slightly swollen at the joints; exothelial cells strongly differentiated; stomata immersed, *very numerous around base of spore sac*, sometimes occurring as high up as the middle of the spore sac; spores in spring. Type locality, on trees, Vancouver Id. (Lyll). Type seen. Mitten's type has the capsules scarcely exserted and calyptra with numerous hairs, leaves slightly contorted.

ILLUSTRATIONS:—Sull. *Icones Musc. Suppl.* 43; R. & C. l. c.; *Pl.* 55.

EXSICCATI:—Holz. 110 & 515 (as *O. pulchellum leucodon*), 109 (as *O. pulchellum*); Howe, *Musc. Calif.* 74 and 81 (as *O. pulchellum*); Macoun. *Can. Musci.* 125; Allen, *Mosses Cascade Mts.* 42 and Heller, *Plants of Washington* (both as *O. ulotaforme*).

On trees, California to Alaska. Common along the West Coast but rare east of the Coast Ranges. Although there are wide variations in size, length of seta, and number of segments, and the calyptra may be naked as well as slightly hairy as in the type, I can see but one specific type, distinguished from *O. pulchellum* and its var. *columbicum* constantly and consistently by the pale teeth without tinge of red, the larger capsule with numerous stomata about the lower part of the spore case and even onto the neck.

O. Hendersoni R. & C. *Bot. Gaz.* l. c. 42 is only a form of *O. consimile* with short seta and slender crispate leaves. Type seen.

The type of *O. ulotaforme* has crispate leaves and an unusually long seta.

Leiberg's 233, on branches of hemlock, Traill R. basin of Idaho, which Cardot referred to *O. Rogeri* is *O. consimile* Mitt. This is the only report of *O. Rogeri* from North America. Unless further data come in this species can be eliminated from our flora. No. 233 was mixed according to Leiberg and it is barely

possible that Cardot found something different, but his memoranda on the specimen indicate that the specimen he examined was the same as that at the N. Y. Botanical Garden. *O. Rogeri* Brid. differs "de l'*O. Hendersoni* par ses feuilles moins crispées excavées à la base et sa capsule atténué insensiblement dans le pedicelle" Cardot in letter to Mrs. Britton 1-8-1890.

This quotation indicates its relationship to the group of *Pulchella*. Perhaps *O. consimile* and *O. Rogeri* are synonyms.

Orthotrichum Winteri Schimp. Bry. Eur. Suppl. fasc. 3-4. pl. 2. 1866, is reported from Vancouver Island but all Macoun's *Winteri* that I have been able to see, including that at Ottawa, is *O. consimile*. The characters which separate *O. Winteri* from *O. pulchellum* are precisely those that distinguish *O. consimile*. The type locality of *O. consimile* is Vancouver Island and it was published before *O. Winteri*. It is up to the European bryologists to determine whether or not *O. Winteri* is a synonym of *O. consimile*.

43. ORTHOTRICHUM DIAPHANUM [Schrad.] Brid. Musc. Recent. 2^o: 29. 1801.

Orthotrichum canum Mitt. Journ. Linn. Soc. 8: 26. 1865.

Tufts small, dense, 0.5-1 cm. high, *grayish green by reason of the hyaline leaf tips*, sparingly branched; leaves loosely imbricate, about 2 mm. long, oblong-lanceolate to oblong-elliptic, sometimes bearing septate brood bodies, *most of the leaves ending in a narrow hyaline rough hair point*, longer in the upper and perichaetial leaves; margins revolute; costa ending in or below the apex; upper leaf cells with cell walls little thickened, irregularly rounded-hexagonal, 14-20 μ in diameter, with simple papillae or nearly smooth; basal rectangular, smooth, less dense, shorter on the margins. Monoicous; seta short, \pm 0.5 mm. long; capsule oblong-elliptic, immersed to emergent, 1.5-2 mm. long, light colored, abruptly narrowed to the seta, smooth to faintly ribbed when dry (said to be strongly ribbed when old in European plants) then subcylindric; calyptra covering $\frac{2}{3}$ of the capsule, nearly or quite naked; operculum conic-rostellate; annulus present; exothecial cells rather thin-walled, differentiated; stomata immersed, near the middle of the capsule; peristome double, the outer of 16 narrowly lanceolate teeth, spreading to recurved when dry, sometimes split at the apex, strongly papillose with high narrow papillae, reaching 0.3 mm. in length in European plants but mostly about 0.2 mm. in American; segments 16, filiform, only a little shorter than the teeth and similarly papillose; spores rough, maturing in late winter and early spring. Type locality European.

ILLUSTRATIONS:—Bry. Eur. pl. 219; Husnot, Musc. Gall. pl. 52; Braithw. Brit. Moss. Fl. 2: pl. 56D; Pl. 50.

EXSICCATI:—Holz. Musc. Acro. Bor. Am. 492; Bartram, Mosses Southern Arizona 57.

On base of trees, Texas, Arizona, Colorado. No specimens of Drummond's plants from "British America" are available, as Mitten's type of *O. canum* cannot be found here or in England.

The length and brittleness of the leaf awn varies a great deal in both American and European plants. The distinctive characters given by Mitten to separate *O. canum* do not seem to hold for any American plants that were available for study. All the characters he gives are variable even in Europe. Sterile plants are likely to be mistaken for a *Grimmia*.

2. ULOTA Mohr.; Brid. Musc. Recent. Suppl. 4: 112. 1819.

Weissia Ehrh. Hanov. Mag. 1779: 1003.

Plants usually small, in dark green tufts, lighter above; primary stems sometimes creeping and sending up a dense mass of short secondary tufts, usually the stems are erect to ascending, 1-3 cm. long; leaves lanceolate to ovate-lanceolate, *curled and twisted when dry* (except *U. americana*, *U. Barclayi* and *U. Funstoni*), more or less keeled, with margins more or less revolute; costa strong, usually ending in or just below the apex; perichaetial leaves scarcely different; upper leaf cells small, thick-walled, rounded, nearly isodiametric, papillose; median basal smooth, elongated, often colored and sometimes nodose, *the marginal shorter and more nearly hyaline*. Monoicous (except *U. phyllantha*); capsules *well exerted*, 8-ribbed when dry and empty, mostly with a very long tapering neck; *stomata superficial, borne on the neck*; peristome like that of *Orthotrichum*, usually double; annulus persistent; operculum hemispheric to conic, short-rostrate; calyptra conic-campanulate, plicate, lobed at base, usually *densely hairy*; ochrea indistinct or lacking. Type species, *Ulotia crispa*.

Distinguished from *Orthotrichum* by the italicised characters. On the one hand it approaches *Orthotrichum* through *U. americana* and on the other it is approached by the *Pulchella* group of *Orthotrichum* with its crispate leaves; but both the groups of *Orthotricha* which may be confused with *Ulotia*, have immersed stomata.

KEY.

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|--|--------------------------|
| 1. Leaves not crisped, scarcely contorted..... | 2. |
| Leaves strongly contorted to crisped..... | 4. |
| 2. Costa percurrent; leaves papillose; mostly rupestral..... | 1. <i>americana</i> . |
| Costa ending below apex; arboreal; perichaetial leaves slightly different..... | 3. |
| 3. Leaves smooth; peristome teeth finely papillose..... | 10. <i>Barclayi</i> . |
| Leaves papillose; peristome teeth coarsely and irregularly papillose with slender salient papillae..... | 11. <i>Funstoni</i> . |
| 4. Many leaves nearly always tipped with clusters of septate brood bodies; dioicous. Leaves not as above; monoicous..... | 9. <i>phyllantha</i> . |
| 5. Capsules smooth except at the puckered mouth..... | 5. |
| Capsules strongly 8-ribbed throughout..... | 6. <i>Ludwigii</i> . |
| 6. Many leaves apiculate with a single cell or a linear aggregate of 2-9 cells; spores very large, 30-60 μ | 6. |
| Leaves not apiculate; spores 15-30 μ | 7. <i>megalospora</i> . |
| 7. Capsules not constricted below the mouth when dry*..... | 7. |
| Capsules constricted below the mouth when dry..... | 8. |
| 8. Leaves very strongly crisped; peristome double..... | 10. |
| Leaves contorted or slightly crisped; peristome single..... | 9. |
| 9. Old capsules fusiform; segments narrowly linear..... | 5. <i>Drummondii</i> . |
| Old capsules obconic-cylindric, always widest at the mouth; segments lanceolate..... | 3. <i>Bruchii</i> . |
| 10. Leaves short, \pm 2 mm. long, with very large subcylindric papillae; peristome teeth striate..... | 4. <i>obtusiuscula</i> . |
| Leaves 2-3 mm. long, with papillae small or nearly lacking; peristome teeth finely papillose..... | 8. <i>curvifolia</i> . |
| | 2. <i>crispa</i> . |

1. ULOTA AMERICANA (P. B.) Limpr. Laubm. 2: 21. 1890. Not of Mitten.

Orthotrichum americanum P. B. Prodr. 81. 1805.*Orthotrichum Hutchinsiae* Sm. Eng. Bot. pl. 2523. 1813.*Orthotrichum strictum* Brid. Bryol. Univ. 1: 289. 1826.*Weissia americana* Lindb. Musc. Scand. 28. 1879.

Plants dark green at the tips, dark purplish brown to almost black below, 1-2 cm. high, rigid, brittle; leaves closely imbricated when dry, crowded, not contorted or crisped, concave-carinate, lanceolate to ovate-lanceolate or oblong-lanceolate, obtuse to obtusely acute, 1.5-2.5 mm. long, 0.4-0.6 mm. wide at base, upper narrower; margins more or less recurved; upper leaf cells papillose, very thick-walled, subcircular to elliptic, lumen 8-10 μ in diameter; median basal strongly colored, very thick-walled, linear, lumen often little wider than the cell wall; marginal basal cells with thinner walls, often colored also. Calyptra very hairy; seta 2-4 mm. long; capsule long exserted, oblong-obovoid with a very long neck about 1 mm. long, urn about 1.7 mm. long, pale yellowish-brown, old capsules subcylindric and much darker in color, becoming more strongly 8-ribbed when dry; exothecial cells differentiated; peristome teeth 16, united in pairs, finely papillose, erect on dehiscence, becoming reflexed later, perforate along the median line above; segments 8, slender, of two rows of cells, about $\frac{1}{2}$ the length of the teeth; spores \pm 15 μ , in early summer. Type from Pennsylvania (Muhlenberg).

ILLUSTRATIONS:—Bry. Eur. pl. 226; Jennings, Mosses W. Pa. pl. 15; Pl. 56.

EXSICCATI:—Sull. Musc. Allegh. 127; Sull. & Lesq. Musc. Bor. Am. (Ed. 1) 123, (Ed. 2) 123; Aust. Musc. Appal. 157, 159; Grout, Musci Perfecti 8.

On noncalcareous rocks, rarely on trees; eastern U. S. and Canada, south to Georgia, west to the Rocky Mts.; Arizona (Bartram). Common in eastern Canada and northeastern U. S.

Rarely short capsules abruptly narrowed to the seta occur, usually in the same tuft with normal ones. This species strongly resembles *Orthotrichum anomalum* in gross appearance, for distinctions see that species.* Occasionally the capsules of *U. obtusiuscula* are somewhat contracted below the mouth when dry and empty.

1a. Var. *RUFESCENS* (E. G. B.) Paris, Index (Ed. 2) 5: 96. 1906.

Weissia americana var. *rufescens* E. G. B. Bull. Torr. Bot. Club. 21: 69. 1894.

"Plants more slender, green or brown, not black, stems rufous tomentose, leaves crowded, longer, often 3 mm. narrower, acuminate, upper cells more dense and obscure, lower golden brown, rectangular, not linear or sinuous, marginal shorter, not hyaline; seta 2 mm. long, neck tapering 0.75 mm.; stomata few, small, theca pyriform, 1.5 long by 1 mm. broad, inflated, narrower at the mouth, ridges continuous of 3-6 rows of cells, broadest at the mouth, not prominent on mature capsules; peristome double, teeth reflexed when dry, white, granulose, not trabeculate at apex, cilia eight, of two rows of cells, fugacious; calyptra with short glossy papillose hairs."

"Summit of White Top, Virginia, on trees in dense woods of *Picea Mariana* and *rubra*, mixed with *Dicranum longifolium*, *Zygodon viridissimus*, *W. ulophylla* and *Frullania Asa-Grayana*. Alt. 5,678 ft."

Similar plants on spruce along the Tennessee-N. Carolina line in the Smoky Mts., National Park have narrower but not longer leaves.

Mrs. Britton, l. c., cites Macoun's no. 33 from Goulay's Point, Aug. 5, 1869 as having short capsules and slender stems; as noted above, I find some short capsules in normal tufts.

2. *ULOTA CRISPA* (Hedw.) Brid. Musc. Recent. Suppl. 4: 112. 1819.

Orithotrichum crispum Hedw. Sp. Musc. 152. 1801.

Weissia ulophylla Ehrh. Beitr. 1: 191. 1787.

**Ulotia camplopoda* Kindb., Macoun, Cat. Can. Pl. 6: 85. 1892.

Ulotia connectens Kindb. l. c.

Ulotia crispa subcalvescens Card. & Thér. Proc. Wash. Acad. Sci. 4: 310. 1902.

Plants in small dense tufts, yellowish-green above, brown below; stems 5-10 mm long, sparingly branched; leaves strongly crisped when dry, narrowly lanceolate from a broader concave base, about 2-3 mm. long, acute to narrowly obtuse, rather strongly papillose above; margins plane; costa strong, vanishing in the apex; upper leaf cells subcircular to transversely elliptical, very thick-walled, lumen 8-10 μ , cell walls about 3 μ in thickness; basal cells as described for the genus; capsules obovoid, well exerted, with a long slender neck, longer than the spore sac, merging insensibly into the (1-2 mm.) seta; capsule with neck and operculum about 2 mm. long, when dry suburceolate and contracted below the mouth immediately after dehiscence, abruptly contracted to the shrunken and wrinkled neck, 8-ribbed as to spore sac; later the spore sac shrinks and the entire capsule become narrowly subcylindric and deeply plicate; exothelial cells differentiated, rectangular along the bands; stomata just below the spore sac; operculum conic-rostrate; peristome teeth 16, more or less united in pairs at first, finely papillose and often perforate near apex, reflexed when dry, 0.20 mm. long; segments 8, of two rows of cells, shorter than the teeth; spores finely papillose, up to 22 μ , maturing in late spring to early summer. Type locality, Germany.

ILLUSTRATIONS:—Bry. Eur. pl. 228; Jennings, Mosses W. Pa. pl. 16; Braithw. Brit. Moss Fl. 2: pl. 59D; M. H. M. pl. 38.

EXSICCATI:—Sull. Musc. Allegh. 29; Sull. & Lesq. Musc. Bor. Am. (Ed. 1) 125 & 126, (Ed. 2) 190; Aust. Musc. Appal. 158, 159; Grout, Musci Perfecti 251 (mixed with var. *crispula*).

On rough bark of deciduous trees in moist regions; eastern U. S. & Canada, south to North Carolina and Tennessee, west to Minnesota; also from Alaska (Kelp Expedition).

From observations in field and laboratory I have come to believe that the var. *crispula* Hammar is nothing but a form of *crispa* in which the shorter spore sac remains at dehiscence without farther shrinking; the neck of the capsule seems much shorter than it really is. It so often appears growing with the typical form, intermixed and intergrading with it that it scarcely seems worth while to rank it as more than an unimportant form. This form has been collected in Florida.

2a. Var. *INTERMEDIA* (Schimp.) n. comb.

Ulotia intermedia Schimp. Syn. (Ed. 2) 395. 1876.

A large form with larger capsules, not contracted under the mouth when dry, becoming long obconic-cylindric with age. Macoun, Can. Musci 320, Ottawa, Oct. 14, 1891, and Husnot, Musc. Gall. 763 from the island of Miquelon are this variety.

* According to Mrs. Britton, Bull. Torr. Bot. Club. 21: 74. 1894.

The European plants of this species seem to be larger than the American, as Limpricht gives the height of the plants as 2 cm. and the length of the leaves as up to 3.6 mm.

The popular belief that mosses grow more abundantly on the north side of trees in the forest has little foundation in fact as far as the eastern U. S. is concerned, but in comparatively open places, *Orthotrichum*, *Uloa* and several other genera are much more abundant on the shaded north side of tree trunks as there they are less exposed to the drying action of direct sunlight.

2b. Var. ALASKANA (Card. & Thér.) n. comb.

Uloa alaskana Card. & Thér. Proc. Wash. Acad. Sci. 4: 309. pl. 15f, 4a-g. 1902 (Harriman Exped.).

Plants yellowish green at the tips; about 2 cm. high, larger than most N. American plants of the species, but not larger than much of the European material; lower leaves more abruptly narrowed from the obovate concave base to a linear or narrowly lanceolate upper portion, which is strongly keeled and slenderly acuminate, often very acute; margins often strongly recurved just above the broad base, plane or somewhat revolute above; upper and perichaetial leaves broader above, occasionally narrowly obtuse; setae uniformly over 2 mm. long; capsules strongly resembling those of var. *intermedia* but somewhat contracted under the mouth when dry. Cotype seen. Type from Point Gustavus, Glacier Bay, Alaska (Coville and Kearney no. 774), also collected at Wrangel, no. 407. Both specimens in the herbarium of the U. S. National Museum. This variety is a robust form with longer seta, with macroscopic differences greater than the microscopic.

3. ULOTA BRUCHII Hornsch. in Brid. Bry. Univ. 1: 794. 1826.

Orthotrichum dilatatum Bry. Eur., fasc. 2-3. pl. 11. 1837 (pl. 227 in the series).

Strongly resembling *U. crispa*, but larger, darker below, reaching 2 cm. long; leaves less strongly crisped, more acute, reaching 4 mm. or more in length, often abruptly widened and concave (ladle-shaped) at base, here reaching 0.75 mm. in width; costa ending at or near the apex, scarcely roughened on the back above; upper leaf cells papillose to nearly smooth, 12-14 μ in diameter; median basal linear-flexuose. Seta 3-5 mm. long; capsule long-exserted, yellow, becoming dark brown with age, when dry short-oblong, always narrower at the mouth, 8-ribbed with a long wrinkled neck, not contracted below the mouth; becoming progressively narrowly fusiform with age, without neck about 1.5-2 mm. long, with a neck nearly as long and bearing numerous stomata; operculum rostrate; peristome teeth 0.3 mm. long; segments nearly as long as the teeth, linear but broader at base; spores warty-papillose, 21-23 μ , maturing in summer. Type locality, Germany.

ILLUSTRATIONS:—Bry. Eur. l. c.; Braithw. Brit. Moss Fl. 2: pl. 59B; M. H. M. 178. f. 85.

On trees. The only American specimen I have seen that seemed to be this species was collected by Miss Grace Cooley at Juneau, Alaska, Aug. 5, 1889. The peristome teeth are lighter colored than usual.

All the other N. American material referred to *U. Bruchii* seems to be *U. obtusiuscula*.

4. ULOTA OBTUSIUSCULA C. M. & Kindb. Macoun, Cat. Can. Pl. 6: 82. 1892.

Very close to *U. Bruchii* but differing consistently in the following particulars; leaves more generally very strongly papillose; costa roughened on the back near the apex by very large papillae; capsule never narrower at mouth when old but rarely contracted under the mouth as in specimens of Macoun's 453 in the Farlow Herbarium, 1.5 mm. long exclusive of the long neck; peristome teeth 0.36-0.48 mm. long, more cancellate above: segments lanceolate, reaching $\frac{1}{2}$ width of teeth at base, irregularly dentate on the edges by the projecting ridges of the articulations; spores in July. Type from "Small maple trees in thickets along the Coquilla River near New Westminster Junction, B. C., April 26. 1889; Can. Musci 523." Pl. 57B.

EXSICCATI:—Macoun, Can. Musci l. c.; Holzinger, Musc. Acro. Bor. Am. 523. On trees and shrubs; Washington; Vancouver Id.; British Columbia (4 collections); Alaska.

5. ULOTA DRUMMONDII (Hook. & Grev.) Brid. Bryol. Univ. 1: 229. 1826.

Orthotrichum Drummondii Hook. & Grev. Edinb. Journ. Sci. 1: 120. 1824.

Uloa bicolor Brid. l. c. Suppl. 792.

Plants dark to yellowish green at the tips, dark brown below; stems creeping, bearing erect secondary stems or branches; leaves lanceolate from an ovate concave base, but little contorted when dry, narrowly

obtuse to acute, reaching 3 mm. in length; margins plane or slightly recurved in part; costa ending below the apex; upper leaf cells about 10 μ in diameter, papillose with low simple papillae. Calyptra sparingly hairy; capsule oblong or clavate with a long tapering neck, exserted on a seta 3-5 mm. long, 8-ribbed to base when dry, when old fusiform much as in *O. Bruchii*, 2 mm. or more in length, pale brown darker with age; exothelial cells strongly differentiated along the ribs; stomata numerous, in several rows, small, about 30 μ in diameter; operculum conic-rostrate; peristome teeth 16, somewhat paired at base, pale, papillose, spreading to recurved when dry; segments lacking or very rudimentary; spores in late summer to autumn. Type locality, near Torfar, Glen Fallach, Scotland.

ILLUSTRATIONS:—Bry. Eur. pl. 210; Braithw. Brit. Moss Fl. 2: pl. 59A.

EXSICCATI:—Drumm. Musc. Am. 263 (as *Bryum nutans* var. *minor*) & 261 (in part as *Bryum carneum* var. *pulchellum*).

On deciduous trees; subalpine and very rare. Reported from Canada, summit of Rocky Mts. (Drummond); Sitka, Alaska (Harrington); Newfoundland and Miquelon.

Like the authors of the Lesq. & James Manual, I have been unable to find any American specimens of this species. There are no specimens in the U. S. National Museum, the N. Y. Botanical Garden, the Farlow Herbarium at Harvard, or the Canadian National Museum at Ottawa.

It differs from *U. Bruchii* and *U. crispa* in the slightly contorted leaves and the smaller and much more numerous stomata.

6. ULOTA LUDWIGII Brid. Musc. Recent. Suppl. 4: 112. 1819.

Plants in rather small tufts or cushions, green to brownish, 5-10 mm. in height, erect to inclined, sparingly branched above by innovations; leaves narrowly lanceolate from a short ovate concave (like a spoon bowl) base, somewhat twisted or crispate when dry, narrowly obtuse to acute, upper leaves 2-3 mm. long; margins plane or slightly recurved; costa vanishing below apex; upper leaf cells small, 10-13 μ , slightly papillose with low broad papillae, incrassate, subcircular to elliptic; median basal linear to oblong, very thick-walled. Capsule, including neck and operculum, about 2 mm. long, long-exserted on a seta 3-6 mm. long, light brown, pyriform, smooth when dry except at the long neck and 8-plicate puckered mouth; exothelial cells short, rounded, incrassate and not differentiated; peristome erect when dry, of 16 teeth united in pairs, finely papillose in vague patterns; segments rudimentary or wanting; spores papillose, about 15 μ , maturing in autumn. Type locality, Germany.

ILLUSTRATIONS:—Bry. Eur. pl. 225; Schwaegr. Suppl. 1²: pl. 51; Braithw. Brit. Moss Fl. 2: pl. 58E; M. H. M. fig. 84; Jennings, Mosses W. Pa. pl. 15.

EXSICCATI:—Drumm. Musc. Am. 146; Sull. & Lesq. Musc. Bor. Am. (Ed. 1) 124, (Ed. 2) 189; Aust. Musc. Appal. 156; Holzinger, Musc. Acro. Bor. Am. 275; Grout, Musci Perfecti 261.

On deciduous trees, preferably those with rough bark standing somewhat in the open. Newfoundland, eastern Canada and northeastern U. S., south to North Carolina, west to Lake Superior.

All recent American material that has been referred to *U. coarctata* is *U. Ludwigii*. *Orthotrichum coarctatum* P. B. Prod. 80. 1805 is doubtfully a synonym.

7. ULOTA MEGALOSPORA Vent. Bot. Centralbl. 44: 389. 1890.

Ulotia subulifolia C. M. & Kindb. Macoun, Cat. Can. Pl. 6: 82. 1892.

Ulotia subulata C. M. & Kindb. l. c.

Plants bright green, growing in dense tufts, often spreading by creeping primary stems, freely divided and branching above with numerous short branches, erect portions reaching 1 cm. or more; leaves 1-2 mm. long, crisped when dry, narrowly lanceolate from a short ovate concave (spoon-shaped) base, carinate above, most leaves filiform-acuminate, often with apex of a linear aggregate of elongated cells, 1-9 in number; perichaetial leaves acute to narrowly obtuse; costa ending in the apex; margins plane or somewhat recurved below; upper leaf cells very thick-walled, irregular and nearly isodiametric or somewhat elongated, 7-10 μ in shortest diameter, 15 μ in the longest, papillose with simple low papillae; median basal cells linear, incrassate, soon shorter above and grading into those of the upper leaf; upper and perichaetial leaves often merely acute, occasionally subobtuse. Calyptra sparsely hairy; seta up to 4 mm. in length; capsules long-exserted, pyriform with a slender tapering neck, about 1.5 mm. long including the neck, when dry deeply 8-ribbed, brown, becoming darker and subcylindric with age, slightly or not at all contracted under the mouth; operculum hemispheric, rostellate; exothelial cells differentiated; peristome teeth 16, united in pairs, pale, finely papillose with papillae more or less in irregular lines, reaching 0.24 mm. in length, more or less per-

forate along the middle line above, at first erect, reflexed when old and dry; segments 8, linear; spores in summer, *very large, 30-45 or even 60 μ , coarsely papillose*. Type from Rigi, near Cle Elum Lake, Washington. *Pl. 57C*.

EXSICCATI:—Drumm. *Musc. Am.* 153 in part; Allen, *Mosses Cascade Mts.* 38; Holzinger, *Musc. Acro. Bor. Am.* 522.

On trees, Washington (4 collections); Westminster Junction, British Columbia (Macoun); Idaho (Leiberg).

In general appearance it strongly resembles *U. crispa*, but the filiform-acuminate leaves and gigantic spores easily identify it. I do not find the small (15 μ) or the very large spores reported by Venturi in the type and the spores are almost warty rather than finely papillose.

A most distinct and interesting endemic species.

Drummond's 153 is rather poorly characterized and the N. Y. Bot. Garden specimen contains *U. curvifolia*.

8. *ULOTA CURVIFOLIA* (Wahlenb.) Brid. *Bryol. Univ.* 1: 392. 1826.

Orthotrichum curvifolium Wahlenb. *Fl. Lapp.* 365. 1812.

Ulotia americana Mitt. *Journ. Linn. Soc.* 8: 26. 1865. Not of P. B. 1805.

Ulotia scabrida Kindb. Macoun, *Cat. Can. Pl.* 6: 83. 1892.

Plants yellow-green at the tips, brown to almost black below, robust; primary stems creeping, secondary erect, 1-2.5 cm. high, branched above, stiff; leaves spreading to recurved, moderately crisped when dry, short \pm 2 mm. long, lanceolate from an ovate-concave base, which is $\frac{1}{4}$ - $\frac{1}{3}$ the length of the leaf, keeled, mostly narrowly obtuse, *papillose above on both sides and the costa with very high rather slender papillae*; margins more or less recurved (very broadly so); upper leaf cells very thick-walled, with lumen 7-10 μ in diameter; median basal linear, with walls nearly or quite the thickness of the lumen, bright golden-brown; extreme angular colored and somewhat inflated, above these the usual short hyaline cells; costa strong, ending just below the apex. Calyptra hairy; seta 2 mm. or more long; capsules light brown, pyriform, narrower at the mouth, darker and subcylindric when old; exothelial cells strongly differentiated along the 8 ribs; peristome teeth 16, more or less united in pairs, *striate*, 0.24 mm. long; segments linear, of two rows of cells, as long as the teeth; operculum conic-rostrate; spores 15-20 μ in diameter, papillose, mature in summer. Type locality, Zirknitz Alps, Austria.

ILLUSTRATIONS:—Bry. *Eur. pl.* 226; Brotherus, *Laubm. Fennosk. fig. 66; Pl. 56*.

EXSICCATI:—Drumm. *Musc. Am.* 153 in part; Holz. *Musc. Acro. Bor. Am.* 241 from Norway.

Alpine or boreal; on noncalcareous rocks; Lake Huron (Todd, Macoun); Hector, Rocky Mts. (Macoun); Upper Canada (Drummond); Lake Lindeman (Williams); Newfoundland (Waghorne); issued in Labrador Mosses as found in the U. S. National Museum as *U. Drummondii*; Spanish River, Ontario (Macoun).

9. *ULOTA PHYLLANTHA* Brid. *Musc. Recent. Suppl.* 4: 113. 1819.

Orthotrichum phyllanthum Steud. *Nom. Crypt.* 304. 1921.

Orthotrichum jutlandicum Brid. *Bryol. Univ.* 1: 296. 1826.

Orthotrichum fasciculare Brid. *l. c.* 297.

Weissia phyllantha Lindb. *Musc. Scand.* 28. 1879.

Ulotia maritima C. M. & Kindb. in Macoun, *Cat. Can. Pl.* 6: 84. 1892.

Plants in dense thick tufts, brownish- to yellowish-green above, dark brown below, 1-3 cm. high, simple or sparingly branched; leaves *long-lanceolate to linear-lanceolate, very strongly crispate when dry*, reaching 3 mm. or more in length, slender-pointed, narrowly obtuse to acute; margins more or less revolute below, mostly plane above; costa stout, vanishing in the apex *or in some of the upper leaves usually excurrent into a thick point bearing numerous oblong-cylindric septate brood bodies*; upper cells strongly papillose, very thick-walled, irregularly rounded, subcircular to elliptical, lumen 7-8 μ in diameter, walls fully $\frac{1}{2}$ as thick; median basal cells linear, colored, very thick-walled. *Dioicous*; calyptra sparingly hairy; seta light red-brown, reaching 1 cm. in length, usually less; capsule exerted much beyond the leaves, when just mature and operculate, brown to light yellow, when dry oblong-ovoid with a long wrinkled neck, scarcely contracted below the mouth and slightly ribbed; when old and dry the capsules become obconic-cylindric, strongly ribbed and darker in color; urn about 1.5 mm. in length exclusive of neck; exothelial cells slightly differentiated; peristome teeth at first erect when dry, later reflexed, 16, at first united in pairs, having 18-20

rectangular finely papillose external plates, somewhat colored; segments 8, about 0.4 mm. long, linear; spores in early summer. Type locality German (Schleswig).

ILLUSTRATIONS:—Bry. Eur. *pl.* 223; Braithw. Brit. Moss Fl. 2: *pl.* 50E; *Pl.* 56.

EXSICCATI:—Holzinger, Musc. Acro. Bor. Am. 188; Allen, Mosses Cascade Mts. 39.

On rocks near the sea, more often on trees inland; Pacific Coast region, Oregon to Unalaska Island. Also reported from Newfoundland, Miquelon; Cape Breton and elsewhere in Nova Scotia; more frequent along our northern coasts than is generally realized.

None of the distinctions given for *U. maritima* will hold, though *phyllantha* varies in all the characters given for *maritima*. In the majority of cases the rock-growing plants, especially those near the sea, are shorter, less yellow, with shorter less attenuate leaves and shorter (2 mm.) seta. In fruiting plants the brood bodies are sometimes lacking. The dark leaf tips covered with brood bodies are discernible with a hand-lens. [See Bull. Torr. Bot. Club 21: 72. 1894, and Dixon, Handb. (Ed. 3) 267.]

10. ULOTA BARCLAYI Mitt. Journ. Linn. Soc. 8: 26. 1865.

Plants very small, 5–8 mm. high, slender, *leaves not crisped*, irregularly appressed-imbricate when dry, erect-spreading when moist, the lower *narrowly lanceolate acuminate*, from an ovate or obovate concave base and slenderly acute at apex; *upper leaves larger*, sometimes reaching 2 mm. in length, *broadly lanceolate, broadly acute to rounded obtuse* in the subsheathing perichaetial leaves; margins plane; costa stout, ending below the apex; *upper leaf cells not papillose* but somewhat bulging, thick-walled, irregularly subcircular, with lumen about 7 μ in diameter, walls 2–3 μ thick; median basal yellow, linear, very thick-walled; hyaline marginal in a wider band than usual. Autoicous; calyptra slightly hairy; capsule well exerted, ovoid, on a 2 mm. seta and a 2 mm. neck resembling that of *Trematodon*, neck and capsule strongly 8-ribbed when dry and shrunken, subcylindric, slightly contracted under the wider mouth; stomata numerous in the upper neck and about the base of spore sac; exothelial cells strongly differentiated in alternating bands, one with wide, rectangular cells with incrassate longitudinal walls, the other much narrower and indistinct; peristome teeth in 8 pairs, reflexed against the capsule wall when dry, densely and minutely papillose; segments 8, filiform, erect when dry, of two rows of cells, nearly as long as teeth but very fragile. Type locality, Sitka, Alaska (Barclay).

ILLUSTRATIONS:—Sull. Icones Musc. Suppl. *pl.* 56; *Pl.* 56.

Also collected by Piper on Alnus at Yukutat Bay. Sullivant remarks l. c. p. 75 that this may be the same species or a variety of *Orthotrichum japonicum* Sull. & Lesq. from Japan.

A most distinct and interesting species. Neither Mitten nor later authors emphasize sufficiently the differentiated perichaetial leaves. Piper's plants from the bark of birch or alder perhaps show this more clearly than the type, which I have not seen.

11. ULOTA FUNSTONI n. sp.

Plantae 5–10 mm. altae; folia siccata leviter contorta, inferiora tenui-lanceolata, ad basin ovata, superiora et perichaetialia ovato-lanceolata, 2–2.3 mm. longa, 0.7 mm. lata, obtusa, saepe apice concava; peristomium dentibus 16, reflexis, superne in axi fenestratis, valde papillois, papillis 1–2 μ altis; sporae 20 μ crassae.

Plants small, 5–10 mm. high, little branched; leaves slightly contorted and imbricate when dry, erect-spreading when moist, the lower *narrowly lanceolate* from an ovate concave base, acute to obtuse, \pm 1.2 mm. long; *upper and perichaetial leaves ovate-lanceolate*, 2–2.3 mm. long, 0.7 mm. broad at base, *broadly obtuse, often concave at apex* as in *Orthotrichum tenellum*; margins mostly plane, often somewhat recurved near base; costa strong, ending below apex; upper leaf cells multifiform, subcircular to elliptic, very thick-walled, irregularly rounded, lumen 6–10 μ in diameter, more or less papillose with low broad papillae; basal cells smooth, the median oblong to linear and colored, the basal marginal shorter but the *hyaline marginal band narrow or lacking*. Autoicous; antheridial buds in the axils of the upper leaves; seta 3–4 mm. long; capsules long-exserted, pyriform-clavate, with a long slender neck 2.3 mm. long, strongly 8-ribbed and somewhat contracted below the mouth when dry and empty, when old subcylindric; operculum conic-rostrate; exothelial cells in alternating strips of oblong-rectangular cells and subcircular to short-oblong cells; stomata numerous, superficial, near the base of the spore sac; peristome teeth 16, reflexed when dry, slender, 0.25–0.35 mm. long, perforate and trabeculate above, pale, darker at base, *papillose with large slender papillae*, 1–2 μ in height; segments not seen, either lacking or very fragile as operculate capsules were studied; spores about 20 μ in diameter, in summer. Type locality, vicinity of Yakutat Bay, Alaska

(Frederick Funston no. 158, 1892). Also collected by Piper, no. 2369a in the same general locality, Aug. 31, 1904,¹ both specimens in herb. U. S. National Museum as *U. Barclayi*. Pl. 57A.

The type was on the bark of a shrub, presumably alder and was closely mixed with *U. megalospora*; fine *U. phyllantha* was found in the same packet but detached. The blunt papillose leaves, larger on upper part of stem, the short cells of the exothecium and the strongly papillose peristome teeth clearly differentiate this from *U. Barclayi* and any other of our N. American species. There were two packets of Funston's 158 in the U. S. National Museum but only one contained *U. Funstoni*. The other contained only the two associated species.

U. Funstoni is evidently a derivative of *U. americana*, from which it is distinguished by its lighter color, larger perichaetial leaves, more coarsely papillose and less paired peristome teeth and larger spores as well as arboreal habitat.

3. AMPHIDIUM (Nees in Sturm, Deutschl. Fl. 2: Heft 17. 1819) emend. Schimp. Bry. Eur. Coroll. 39. 1856.*

Amphoridium Schimp. Syn. (Ed. 1) 247. 1860.

Plants in soft dense tufts or cushions, often of considerable extent, dark to yellowish-green, brown below; stems more or less branched, radiculose, evenly foliate, without central strand; leaves narrowly lanceolate, papillose both sides with low papillae, contorted to crispate when dry; costa nearly or quite percurrent, with median guides; upper leaf cells incrassate, more or less rounded-quadrate to rounded-hexagonal, often dense; basal rectangular, less incrassate, hyaline or somewhat colored, smooth; perichaetial leaves more or less sheathing, more or less differentiated, with the elongated smooth cells extending higher up. Autoicous or dioicous; seta erect or slightly curved, gradually enlarged to the long neck of the capsule; capsules mostly erect and symmetric, emergent to exserted, pyriform, strongly 8-ribbed and often urceolate and contracted below the mouth when dry and empty; exothecial cells differentiated along the ribs and capsule mouth bordered by several rows of smaller cells; stomata superficial, in the capsule neck; annulus and peristome lacking; calyptra smooth, cucullate, not plicate.

KEY.

- | | |
|--|--------------------------|
| 1. Leaves distantly toothed..... | 3. <i>californicum</i> . |
| Leaves entire..... | 2. |
| 2. Autoicous; leaf margins plane; perichaetial leaves entirely smooth, not papillose above | 1. <i>lapponicum</i> . |
| Dioicous; leaf margins more or less recurved; perichaetial leaves papillose near apex.. | 2. <i>Mougeotii</i> . |

* See Limpricht, Laubm. 2: 4.

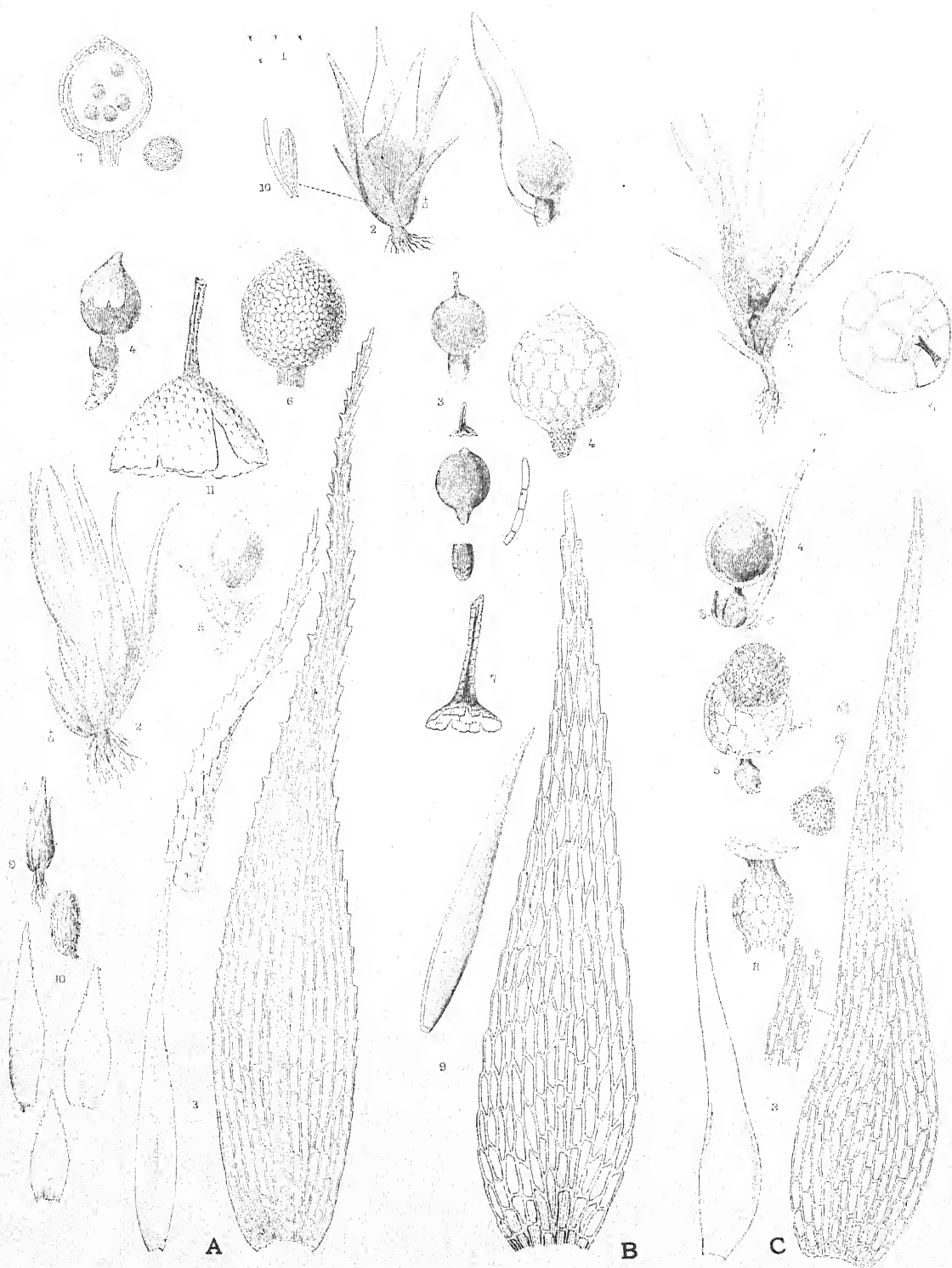


PLATE XXVI.

PLATE 26. A. *Ephemerum crassinervium* var. *papillosum* (from Sull. Icones Musc. Suppl. pl. 10). 2, plant; 3, leaves; 4, 5, 6, capsules; 7, capsule in longitudinal section; 9, antheridial bud; 10, antheridium and perigonial leaves; 11, calyptra. All greatly enlarged.

B. *Ephemerum megalosporum* (from Sull. l. c. pl. 11). 1, plants $\times 1$; 2, plant much enlarged; 3, 4, capsules; 7, calyptra; 9, leaves, one showing cells.

C. *Nanomitrium synoicum* (from Sull. l. c. pl. 13). 2, plant much enlarged; 3, leaves and leaf cells; 4, 5, capsules; 7, operculum with calyptra; 8, vaginula.

PLATE 27. A. A-G, *Ephemerum spinulosum*. A, rhizome-like underground structure bearing above ground the protonema; B, $\times 33$; C, plant $\times 7$; D, plant $\times 20$; E, leaves showing costa $\times 20$; F, basal leaf cells $\times 200$; G, calyptra $\times 50$.

a-e. *Ephemerum serratum* var. *minutissimum*. a, plant $\times 20$; b, c, leaves $\times 50$; d, leaf margin $\times 200$; e, calyptra $\times 20$.

1-4. *Ephemerum spinulosum* var. *texanum*. 1, plant $\times 20$; 2, leaf $\times 50$; 3, calyptra $\times 50$; 4, capsule from above $\times 14$. (All drawings in A by Seville Flowers.)

B. *Funaria Muhlenbergii*. A, leaves from Bartram's no. 58 $\times 10$; B, leaf of antheridial branch from no. 559 $\times 25$; C, leaf apices $\times 25$; D, leaf apex from no. 23 $\times 50$; E, plant from no. 557 $\times 1$; F, very large ripe capsule $\times 5$; G and H, moist and dry capsule respectively from no. 23 $\times 5$; I, old capsule from no. 559 $\times 5$; J, calyptra $\times 5$; K, archegonium and paraphysis $\times 25$; L, stoma $\times 150$; M, spores $\times 150$; N, peristome teeth of var. *lineata* $\times 75$; O, single tooth $\times 300$, the lines are too faintly indicated.

(Figures N and O by Seville Flowers, the others by Bartram from specimens with markedly serrate leaves.)

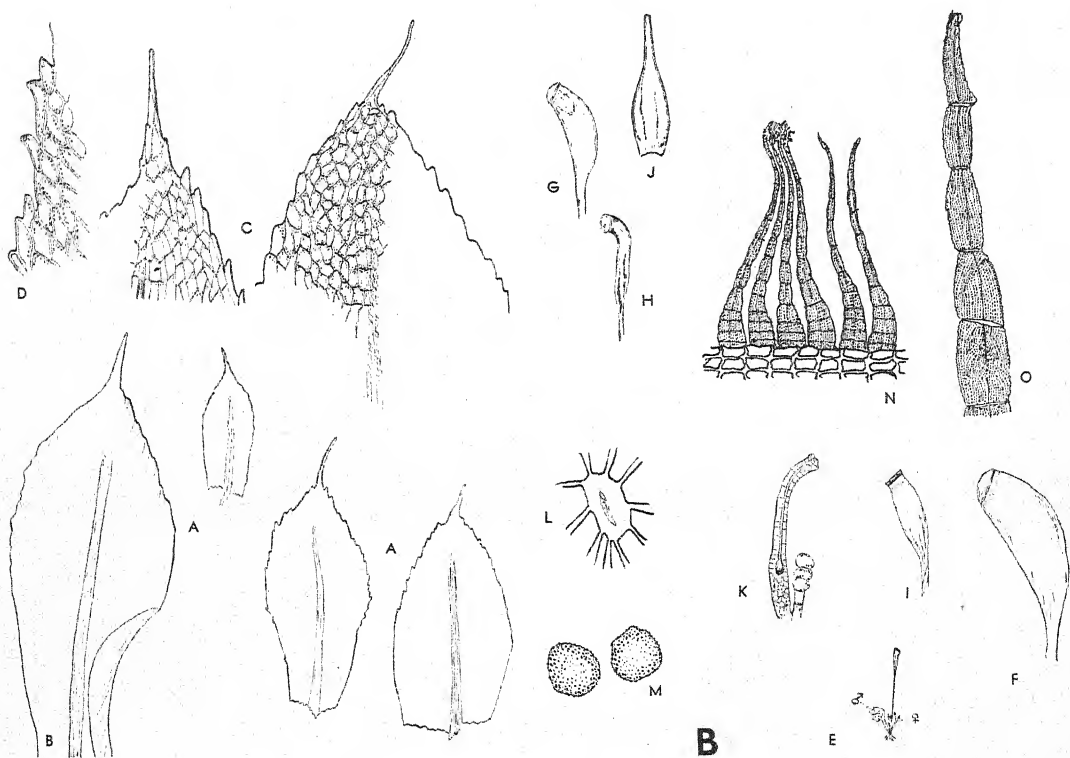
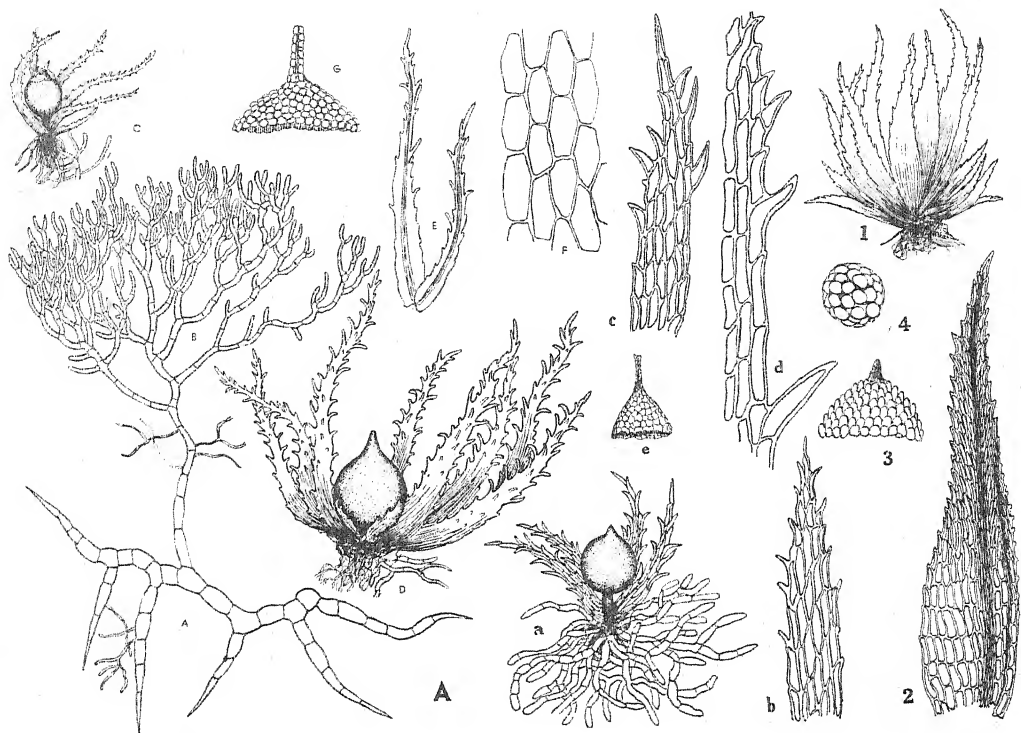


PLATE XXVII.

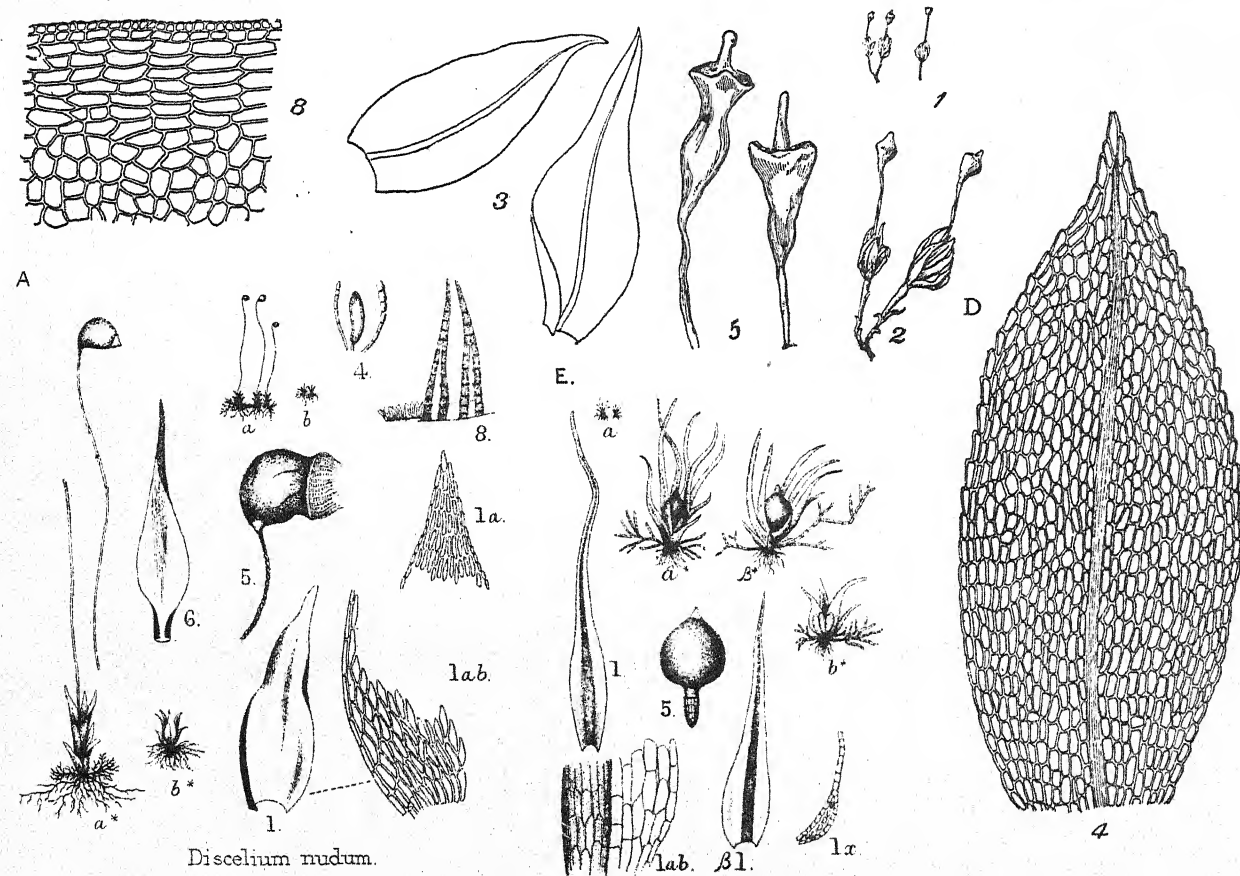
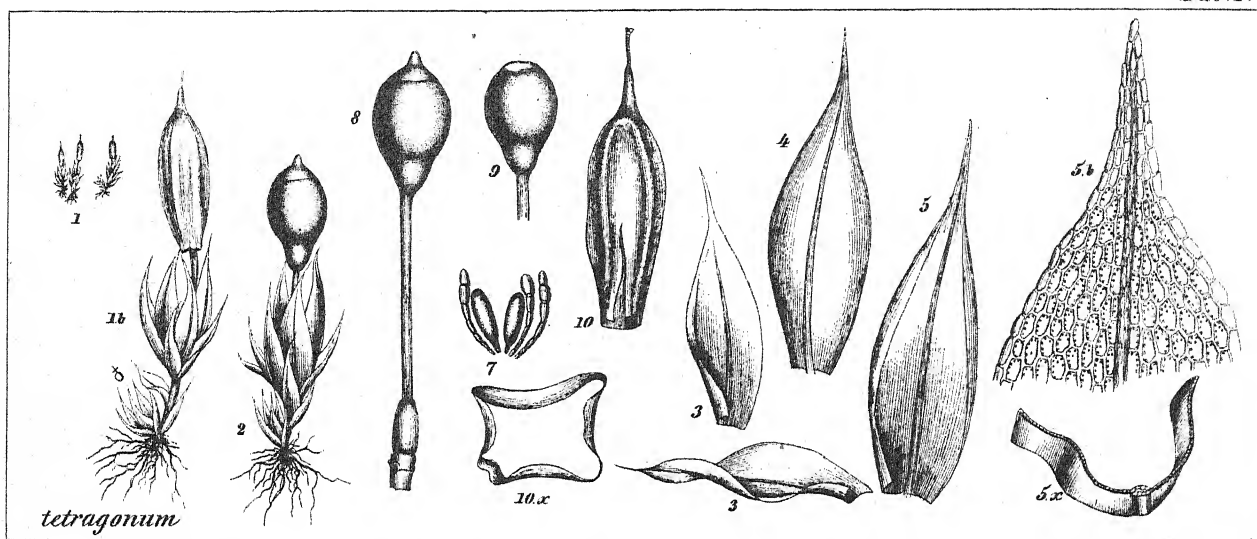


PLATE 28. Top, *Pyramidula tetragona* (from Bry. Eur. *pl.* 298). 1, plants $\times 1$; 2, same much enlarged; 3, 4, 5, leaves; 5b, cells at leaf apex; 5x, cross section of leaf; 7, antheridia and paraphyses; 8, 9, capsules; 10, calyptra; 10x, cross section of calyptra.

A. Discelium nudum (from Braithw. Brit. Moss Fl. 2: *pl.* 64). *a*, *b*, female and male plants respectively $\times 1$; *a**, *b**, the same much enlarged; 1, leaf with cells of apex at 1a, and of base at 1b; 4, antheridium and paraphyses; 5, capsule; 6, calyptra; 8, annulus and peristome teeth.

E. Ephemerum sessile (from Braithw. l. c. 1: *pl.* 27). Lettering same as in *A.* β is var. *brevifolium*. No specimens of this have been found in North America as yet.

D. Physcomitrium Kellermani var. *Drummondii* (from Bull. Torr. Bot. Club 21: *pl.* 201). 1, plants $\times 1$; 2, same enlarged; 3, leaves; 4, leaf showing cells; 5, capsules; 8, cells at mouth of capsule.

PLATE 29. A. *Aphanorhegma serratum* (from Bull. Torr. Bot. Club 22: pl. 230). 1, plants $\times 1$; 2, same enlarged; 3, leaves; 4, basal leaf cells; 5, apical cells; 6, stem with perichaetial leaves removed showing archegonia and antheridia mixed in the leaf axils; 7, antheridial cluster; 8, paraphysis; 9, plant with leaves removed; 10, capsule dehiscing; 11, spores; 12, collenchymatous exothecial cells; 13, same of operculum; 14, stomata; 15, calyptra.

B. *Aphanorhegma patens* (from Bull. Torr. Bot. Club 22: pl. 229). 1, plants $\times 1$; 2, 3, same enlarged; 4, leaves; 5, cells at base of leaf; 6, cells at leaf apex; 7, capsule enlarged to show cells of exothecium and stomata; 8, exothecial cells along the line of dehiscence; 9, enlarged apex of capsule; 10, 11, spores differently enlarged; 12, stoma; 13, calyptra.

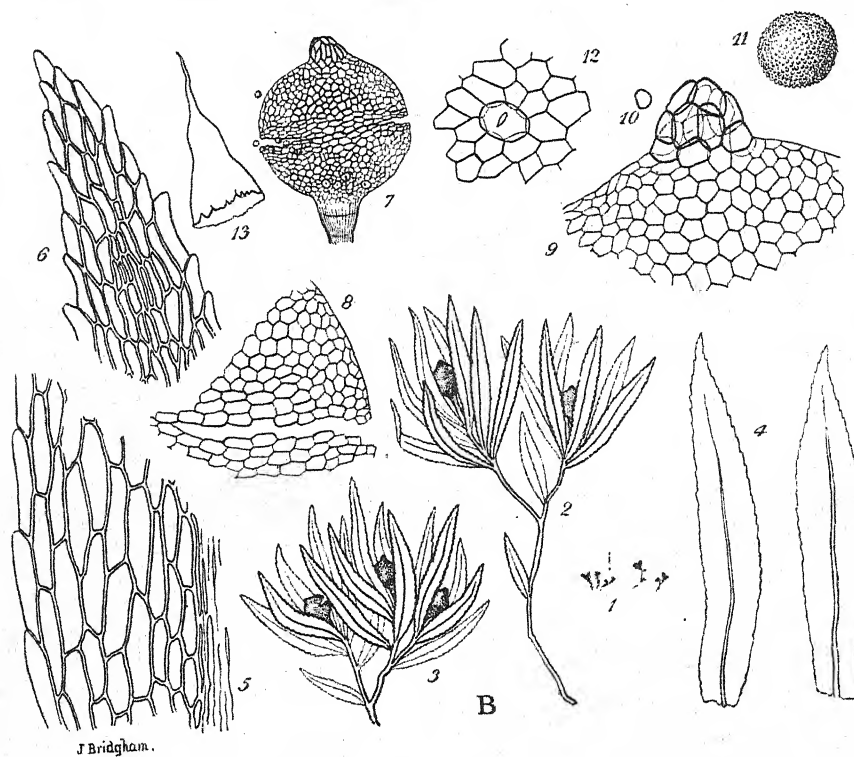
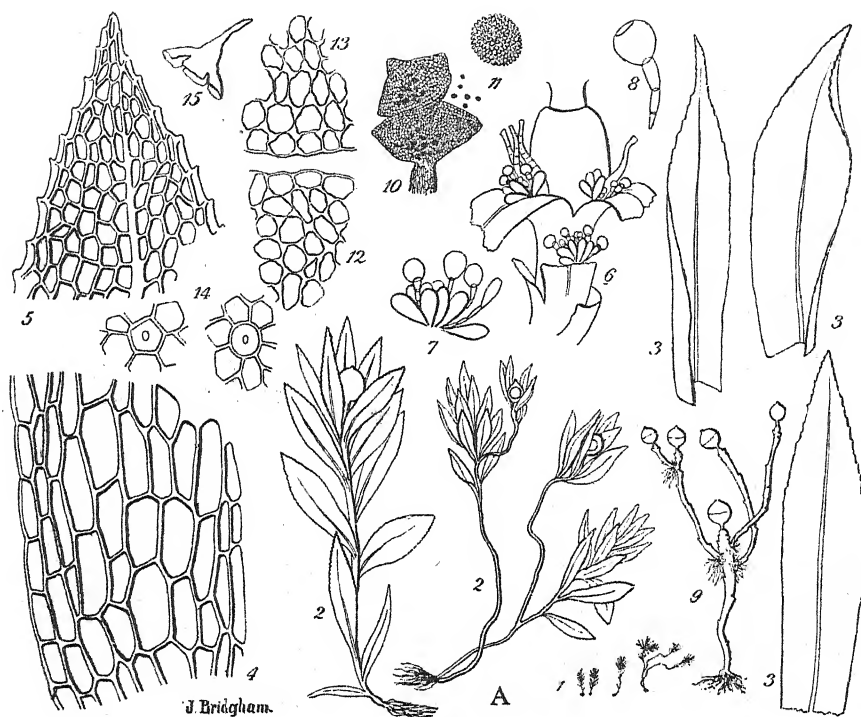
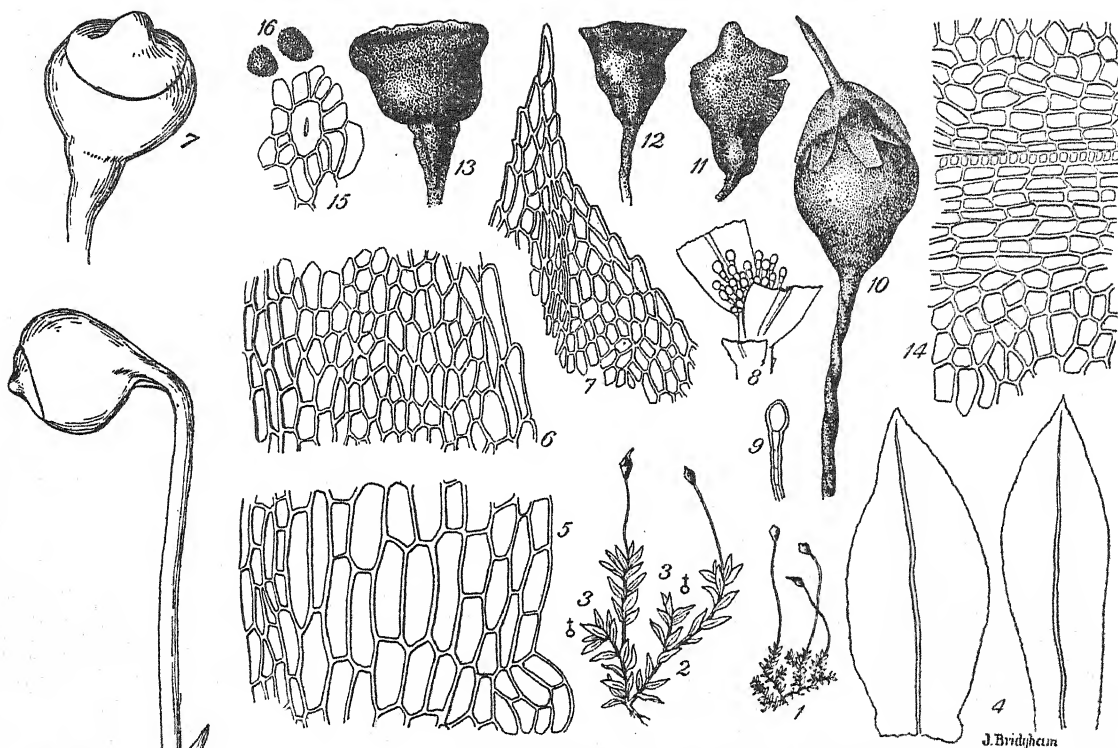


PLATE XXIX.



PHYSCOMITRIUM TURBINATUM MICHX.

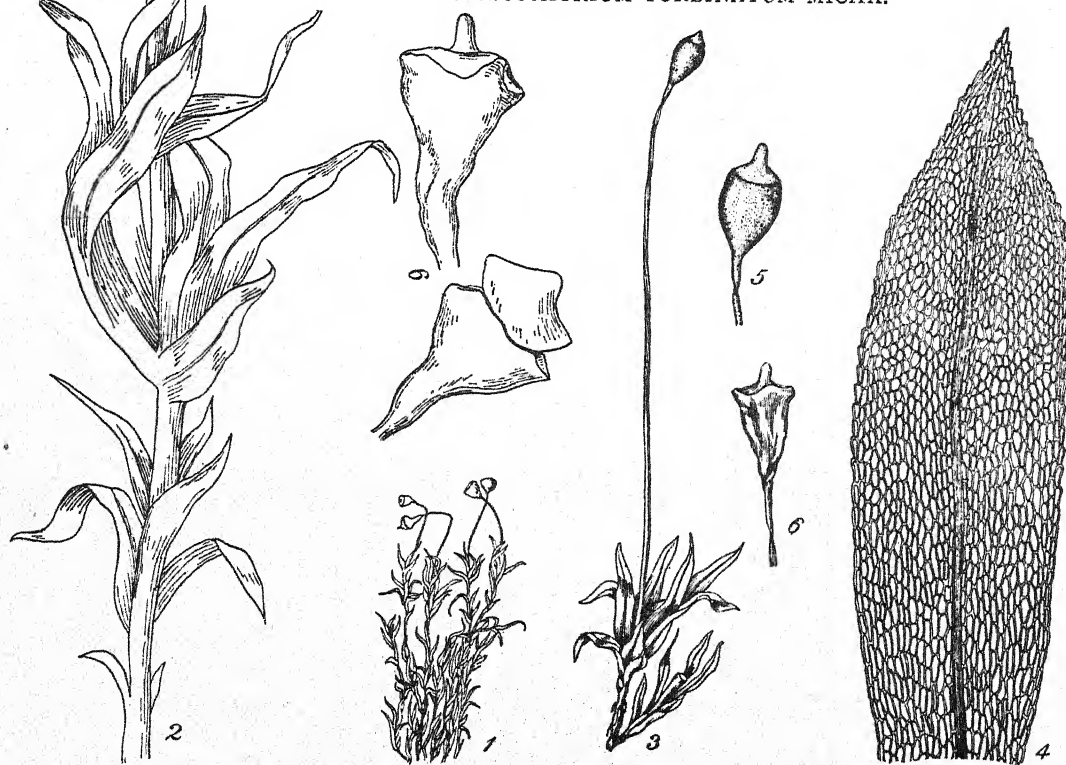


PLATE XXX.

PLATE 30. *Physcomitrium turbinatum* (from Bull. Torr. Bot. Club, 21: pl. 198 and 199). 1, plants \times 1; 2, enlarged; 4, leaves; 5, 6, 7, basal, median and apical leaf cells respectively; 8, 9, paraphyses; 10, 11, 12, 13, capsules; 14, exothecial cells of capsule mouth and base of operculum; 15, stoma; 16, spores. Lower right, var. *Langloisii*. 3, plant enlarged; 5, 6, capsules; 4, leaf. Left, var. *australe*. 1, plants; 2, plant greatly enlarged; 6, 7, capsules.

PLATE 31. 2-10. *Physcomitrium acuminatum* (from Bry. Eur. *pl.* 300). 2-4, leaves; 4a, cells of leaf apex; 5, antheridium and paraphyses; 6-8, capsules; 9, calyptra; 10, spores.

a-f. *Physcomitrium pygmaeum* (from Bull. Torr. Bot. Club, 21: *pl.* 197). a, plants $\times 1$; b, plant greatly enlarged; c, leaf; d, cells at mouth of capsule; e, calyptra; f, leaf apex showing cells.

A-G. *Physcomitrium megalocarpum* var. *californicum* (from Bull. Torr. Bot. Club, 21: *pl.* 203). A, plants $\times 1$; B, plant greatly enlarged; C, leaf and leaf cells; D, capsules; E, cells at mouth of capsule; F, antheridia; G, spores.

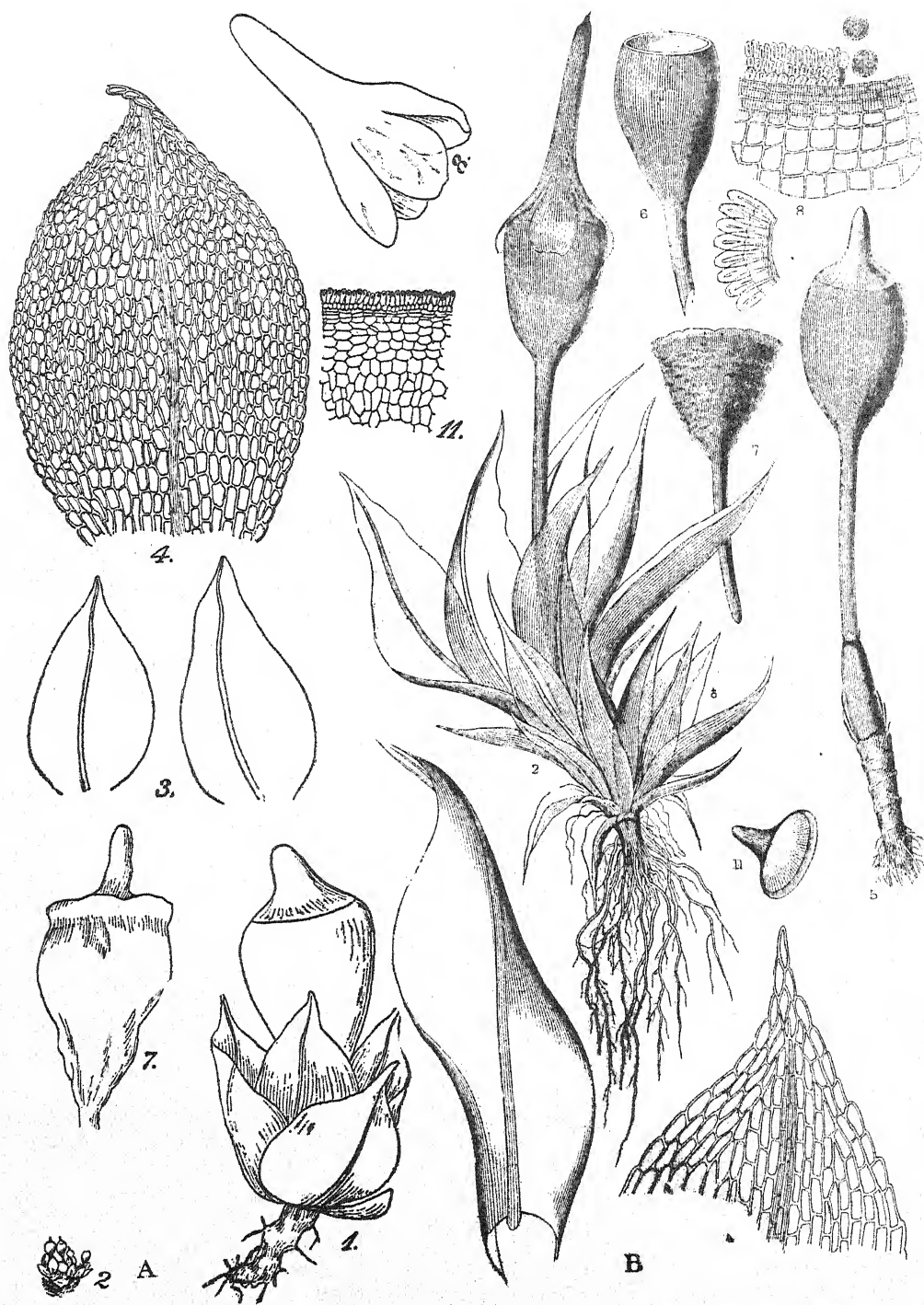


PLATE XXXII.

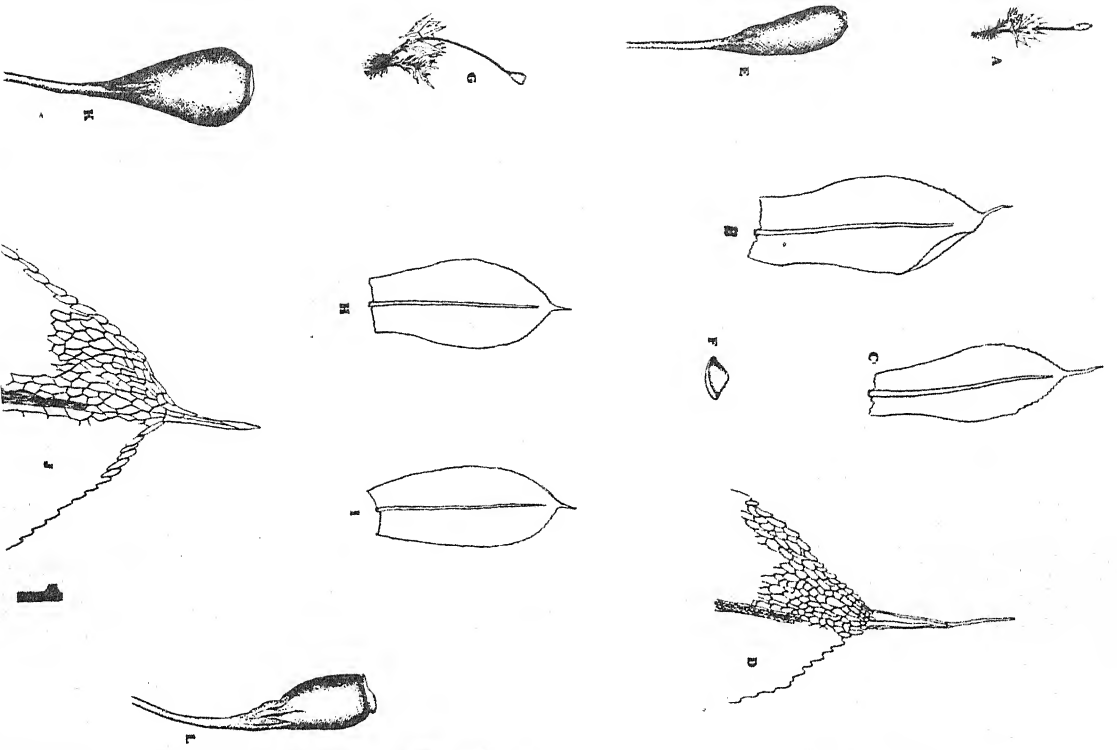
PLATE 32. A. *Physcomitrium coloradense* (from Bull. Torr. Bot. Club, 21: pl. 202). 2, plants $\times 1$; 1, same enlarged; 3, leaves; 4, leaf showing cells; 8, calyptra; 11, cells at mouth of capsule.

B. *Physcomitrium Hookeri* (from Sull. Icones Musc. pl. 16). 2, plant enlarged; 4, leaf and leaf apex; 5, 6, capsules; 7, dry capsule; 8, annulus and cells at mouth of capsule.

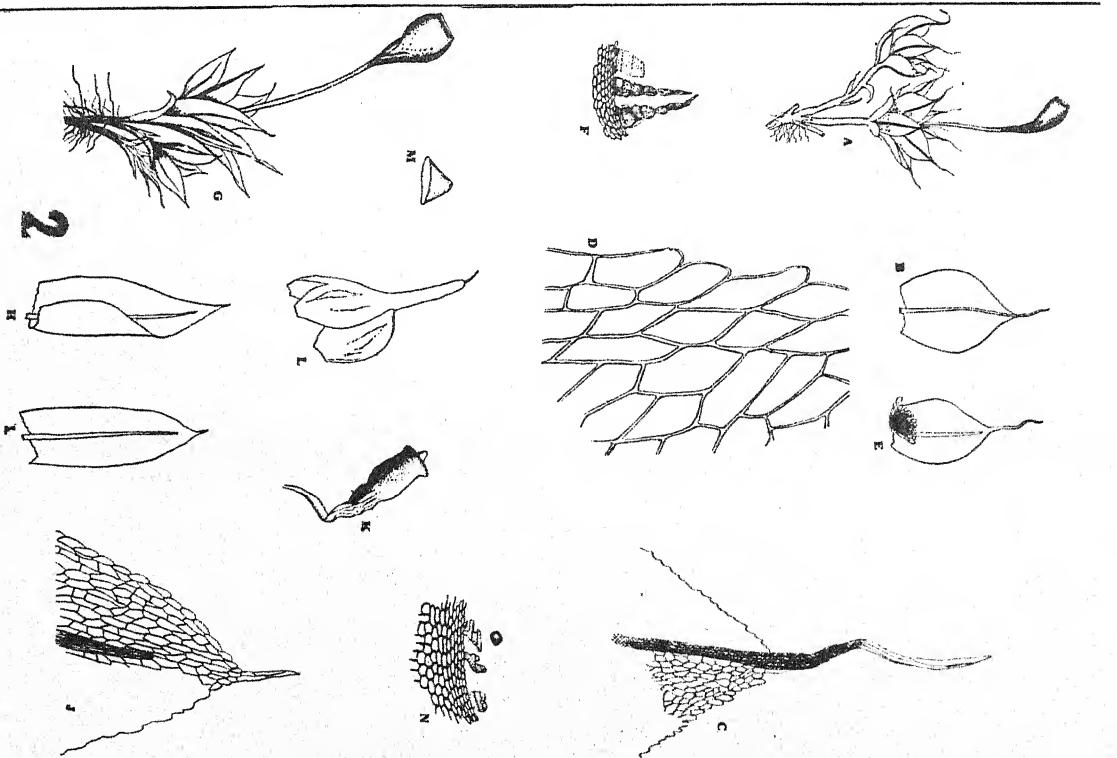
PLATE 33. 1-6. *Physcomitrium Kellermani*. 1, plants $\times 5$; 2, leaves $\times 20$; 3, leaf apices, left $\times 150$, right $\times 300$ (the costa is often much more strongly excurrent); 4, basal cells $\times 150$; 5, median cells $\times 150$; 6, capsule $\times 10$.

a-h. *Physcomitrium megalosporum*. a, plants $\times 1$; b, c, leaves $\times 20$; d, cells of leaf margin $\times 150$; e, of leaf apex $\times 150$; f, basal cells $\times 150$; g, partially dry capsule $\times 10$ (when fully dry it is much more strongly contracted below the mouth and urceolate); h, moist ripe capsule $\times 10$.

A-K. *Entosthodon Bartramii*. A, plant $\times 1$; B, moist plant $\times 5$; C, dry plant $\times 5$; D, sporophyte $\times 10$; E, leaves $\times 32$; F and G, lower leaves $\times 32$; H, basal cells $\times 200$; I, median cells $\times 200$; J, apical cells $\times 200$; K, peristome teeth $\times 150$. (All drawings by Seville Flowers).



1



2

PLATE 34. 1, A-F. *Entosthodon rubisetus*. A, moist plant $\times 1.14$; B, C, Stem leaves $\times 11.5$; D, apex of leaf $\times 48$; E, moist capsule $\times 7$; F, operculum $\times 11.5$. G-L. *Entosthodon plano-convexus*. G, moist plant $\times 1.7$; H, I, leaves $\times 11.5$; J, apex of leaf $\times 48$; K, moist operculate capsule $\times 11.5$; L, partially dry operculate capsule $\times 11.5$. (From Bryol. 31: pl. 9.)

2, A-F. *Funaria Orcutti*. A, moist plant $\times 5$; B, upper stem leaf $\times 10$; C, apex of stem leaf $\times 42$; D, upper leaf cells and margin $\times 240$; E, inner perigonal leaf with cluster of antheridia $\times 30$; F, part of peristome $\times 80$. G-N. *Entosthodon Tucsoni*. G, moist plant $\times 5$; H, I, upper stem leaves $\times 10$; J, apex of stem leaf $\times 42$; K, dry capsule $\times 10$; L, calyptra $\times 10$; M, operculum $\times 10$; N, part of peristome $\times 42$. (From Bryol. 31: pl. 8.)

PLATE 35. A. *Entosthodon Bolanderi* (from Sull. Icones Musc. Suppl. pl. 17). 1, plants $\times \frac{5}{6}$; 2, single plant enlarged; 3, 3, 4, 5, leaves and leaf cells; 6, antheridia, paraphyses and perigonal leaf; 7, archegonium and paraphyses; 8, vaginula and base of seta; 9, antheridium and paraphysis more enlarged; 10, operculate capsule; 11, peristome teeth; 12, peristome; 13, calyptra.

B. *Entosthodon Drummondii* (from Sull. Icones Musc. pl. 55). 1, plants $\times \frac{5}{6}$; 2, 3, 4, fertile plants; 5, perichaetial leaf; 6, cells of leaf apex; 7, 8, 9, capsules; 10, peristome; 11, three teeth; 12, vertical section of tooth; 13, 14, 16, antheridia; 15, calyptra.

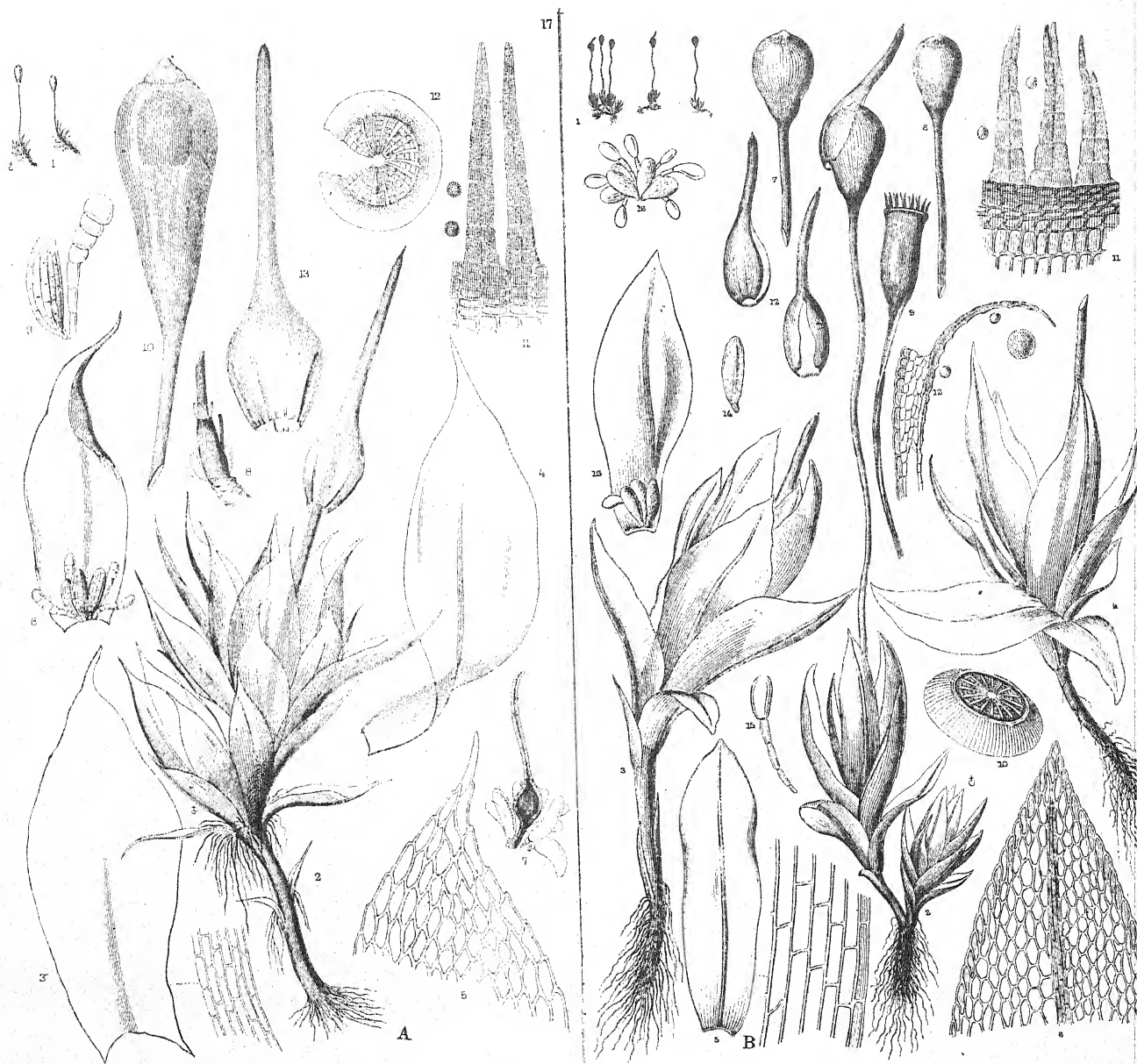


PLATE XXXV.

PLATE 36. Figs. 1-6. *Entosthodon Leibergii* (from Bryologist, 3: pl. 1). 1, plant $\times 1$; 2, capsules enlarged; 3, lower leaf; 4, upper leaves; 5, stomata and exothecial cells; 6, 7, 8, apical, angular and median leaf cells respectively; 9, part of peristome; 10, leaf cells of operculum.

Figs. A-G. *Entosthodon neoscoticus* (from Bryol. 35: 17, f. 1). A, plant $\times 2$; B, leaves $\times 15$; C, operculum $\times 20$; D, calyptra $\times 220$; E, capsules $\times 16$; F, annulus $\times 220$; G, cells from mouth of capsule $\times 220$.

Figs. 1a-1g. *Entosthodon spathulifolius* (from Proc. Wash. Acad. Sci. 4: pl. 17). 1a, plant $\times 1$; 1b, b, b, leaves $\times 13$; 1c, d, e, f, leaf cells of base, lower portion, upper portion and apex respectively $\times 135$; 1g, capsule and calyptra $\times 13$; 1h, calyptra $\times 13$; 1i, immature capsule $\times 13$.

PLATE 37. A. *Entosthodon rubiginosus* (from Bryol. 16: pl. 4). 10, plant $\times 1$; 11, part of lower operculum $\times 100$; 12, peristome $\times 100$; 13, perichaetial leaf $\times 12$; 14, middle stem leaf $\times 12$; 15, upper exothecial cells $\times 40$; 16, apex of perichaetial leaf $\times 100$; 17, deoperculate capsule $\times 5$; 18, operculate capsule $\times 5$; 19, calyptra $\times 5$.

Lower part, *Entosthodon attenuatus* (from Bryol. Eur. pl. 302). 3, 4, leaves; 4b, cells of leaf apex; 4x, cross section of leaf; 8, 9, capsules; 10, mouth of capsule showing peristome; 11-13, different views of peristome teeth; 14, spores; (all greatly enlarged).

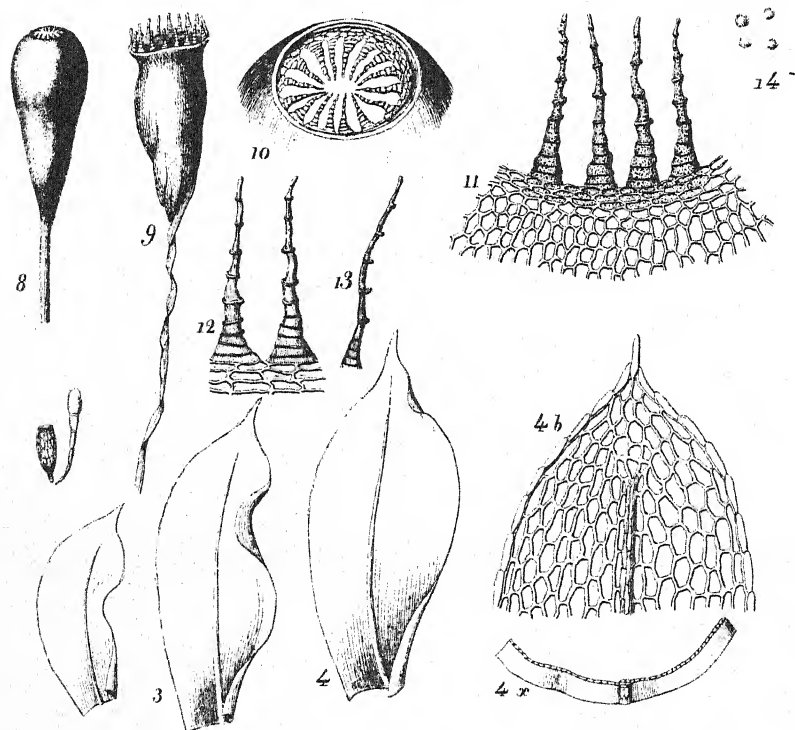
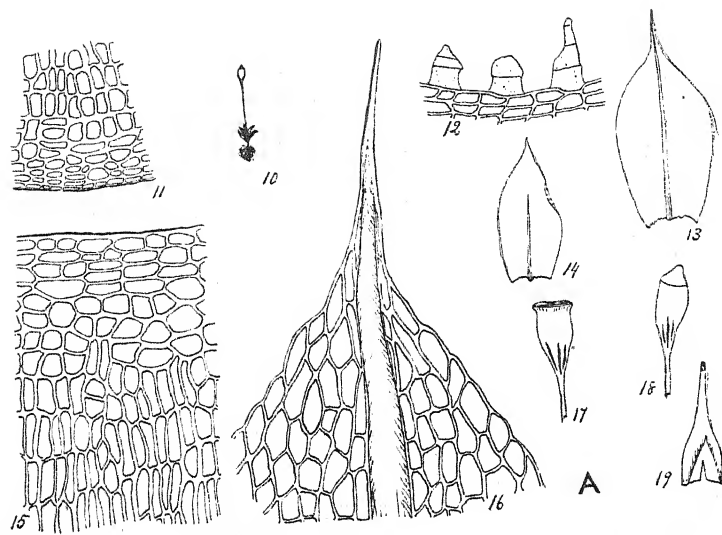


PLATE XXXVII.

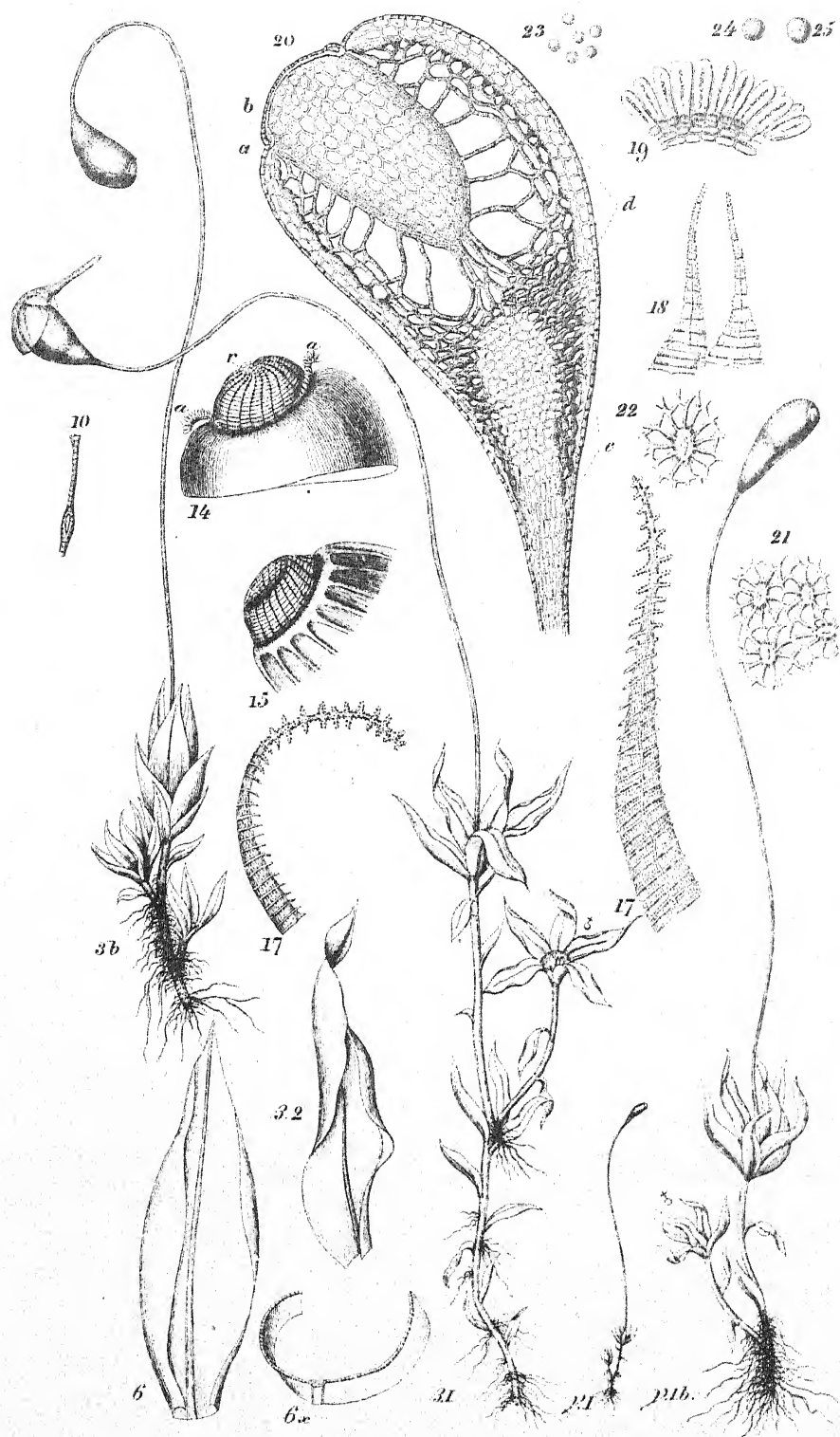
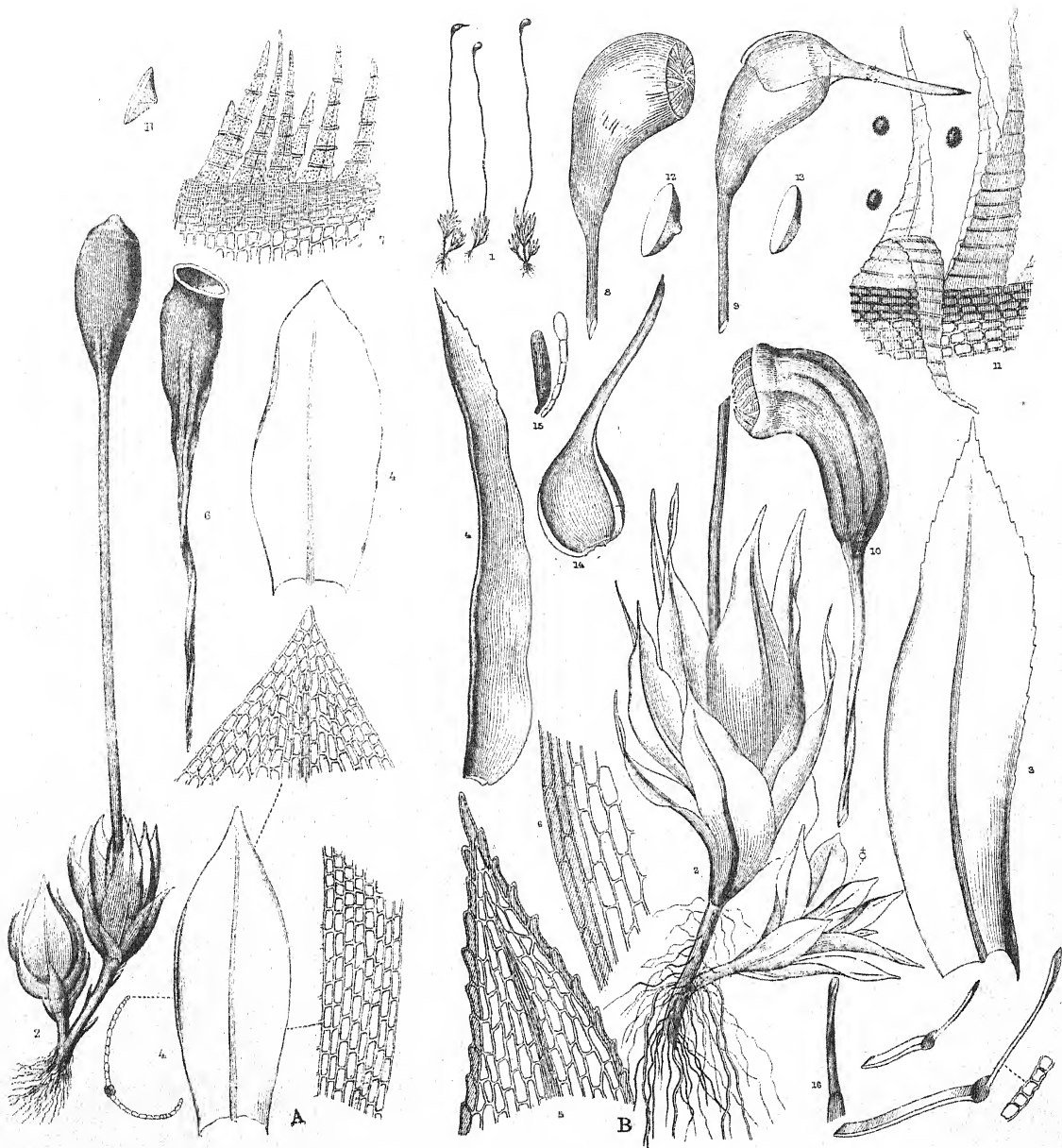


PLATE XXXVIII.

PLATE 38. *Funaria hygrometrica* (from Bryol. Eur. pl. 305). 3b, plant enlarged; 6, leaf; 6x, cross section of the same; 10, archegonium; 14, fresh deoperculate capsule showing annulus; 15, mouth of dry capsule; 17, peristome tooth, lateral view; and dorsal view at the right; 18, two segments of inner peristome; 19, annulus; 20, longitudinal section of capsule; 21, 22, stomata; 23, 24, 25, spores. β 1, var. *paupula*; β 2 leaf of the same; γ 1 and γ 1b, plant natural size and enlarged of var. *calvescens*.

PLATE 39. A. *Funaria californica* (from Sull. Icones Musc. Suppl. pl. 18). 2, plant $\times 10$; 4, leaf with areolation and cross section; 6, dry and empty capsule; 7, part of the peristome; 11, operculum.

B. *Funaria serrata* (from Sull. Icones Musc. pl. 54). 1, plants natural size; 2, stem with leaves and antheridial branch; 3, 4, leaves; 5, cells of leaf apex; 6, same of basal margin; 7, cross sections of leaf; 8, deoperculate capsule; 9, capsule with operculum and calyptra; 10, dry capsule; 11, part of peristome; 12, 13, opercula; 14, calyptra; 15, antheridium and paraphysis; 16, base of seta.



FUNARIA SERRATA, Beauv.

PLATE XXXIX.

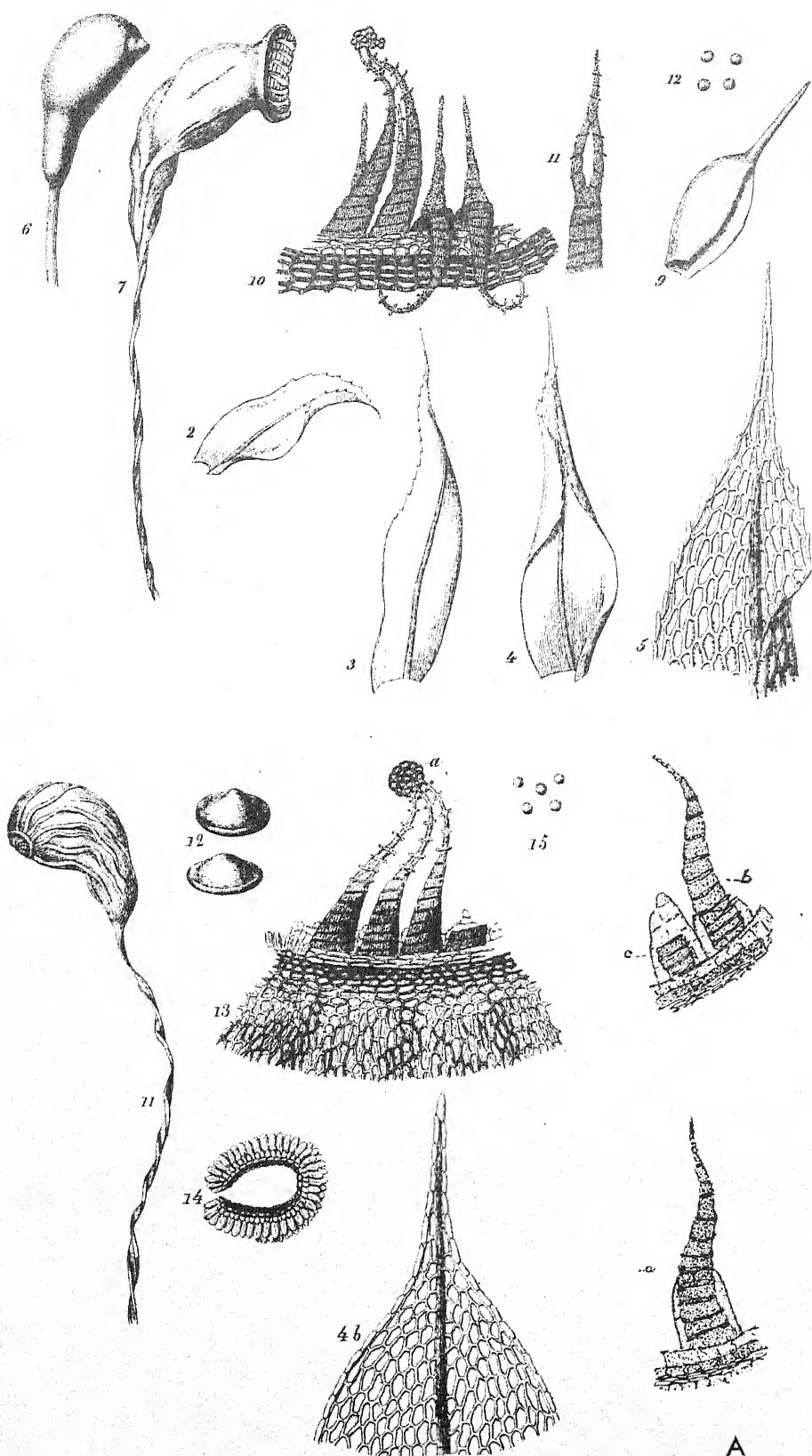


PLATE XL.

PLATE 40. A. Peristome teeth and segments of *Funaria flavicans* (from Bryol. 32: pl. 6). *a*, tooth with segment; *b*, tooth with torn segment; *c*, broken tooth and segment.

Above, *Funaria Muhlenbergii* (from Bryol. Eur. pl. 304). 2-4, leaves; 5, cells of leaf apex; 6 and 7, fresh and old capsules; 9, calyptra; 10, portion of peristome; 11, perforate tooth; 12, spores.

Below, *Funaria microstoma* (from Bryol. Eur. pl. 306). 4*b*, leaf apex; 11, dry deoperculate capsule; 12, opercula; 13, portion of peristome; 14, annulus; 15, spores.

PLATE 41 (from Husnot, Musc. Gall.). *Tayloria serrata* (pl. 55). 1, plant slightly enlarged; 2, leaf; 3, moist capsule; 4, empty capsule; 5, peristome tooth; 6, calyptra; 7, spores; 8, plant and capsule of var. *tenuis*; 9 and 10, leaf and empty capsule of the same.

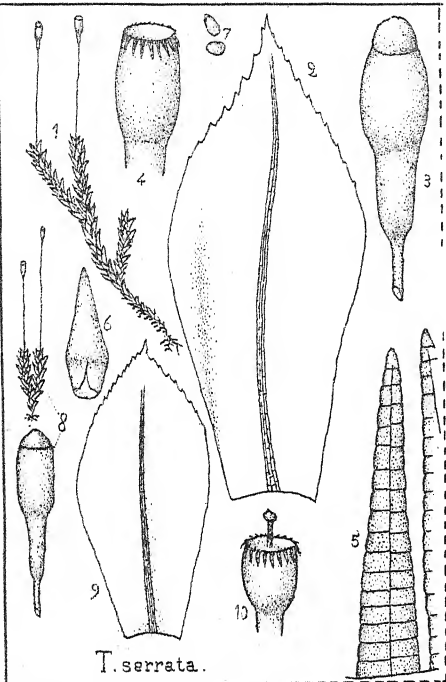
Tayloria splachnoides (pl. 55). 1, plant about natural size; 2, leaf; 3, moist capsule; 4, capsule showing peristome; 5, peristome tooth; 6 and 7, capsule and peristome tooth of var. *acuminata*.

Tetraplodon urceolatus (pl. 55). 1, plant $\times 1$; 2, leaf; 3, 4, capsules; 5, portion of peristome.

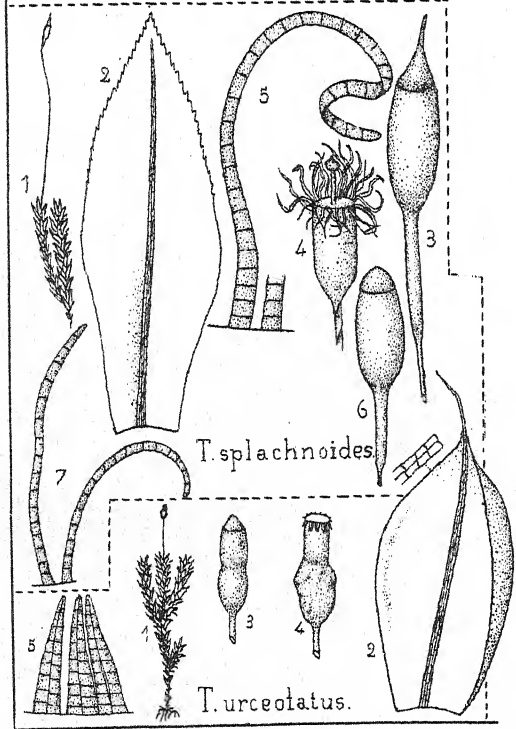
Tetraplodon angustatus (pl. 55). 1, plant $\times 1$; 2, leaf; 3, upper portion of plant enlarged; 4, dry capsule; 5, portion of peristome; 6, calyptra.

Splachnum ovatum (*S. spaericum*, pl. 56). 1, plant $\times 1$; 2, leaf; 3, male inflorescence; 4, 5, capsules; 6, portion of peristome; 7, calyptra.

Splachnum vasculosum (pl. 56). 1, plant $\times 1$; 2, leaf; 3, 4, capsules moist, and dry and empty.

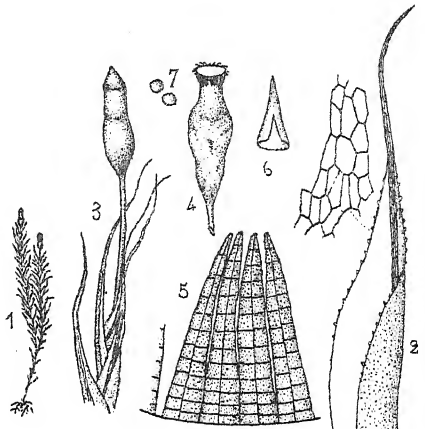


T. serrata.

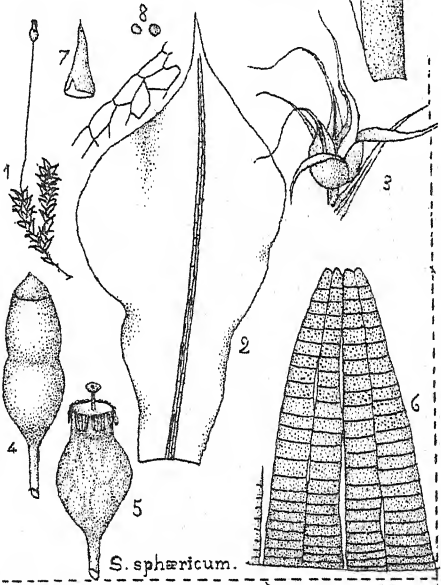


T. splachnoides.

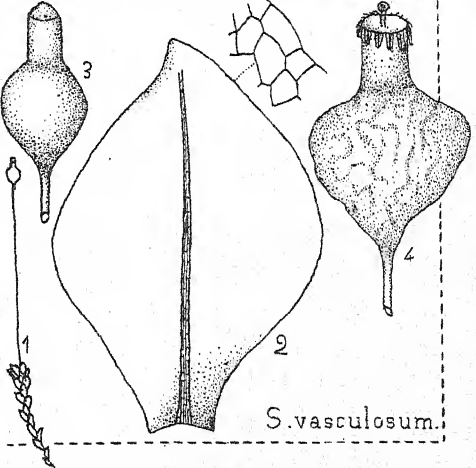
T. urceolatus.



T. angustatus.



S. sphaericum.



S. vasculosum.

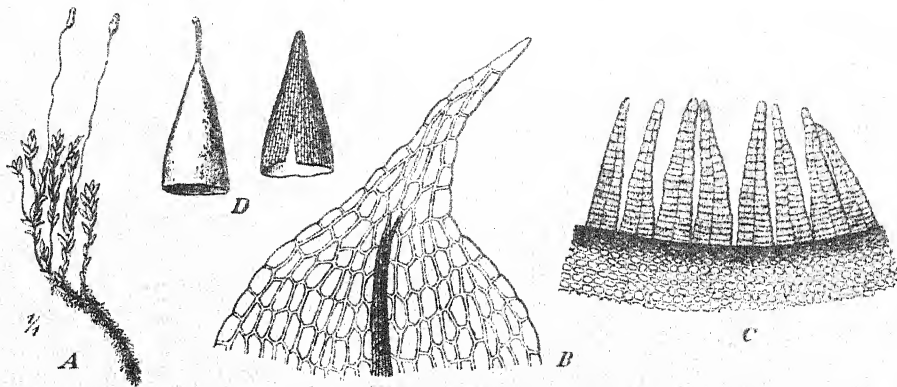
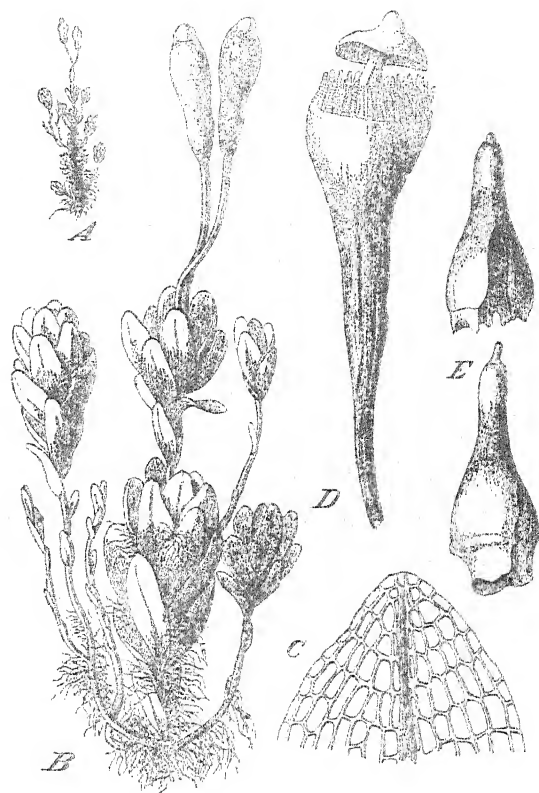
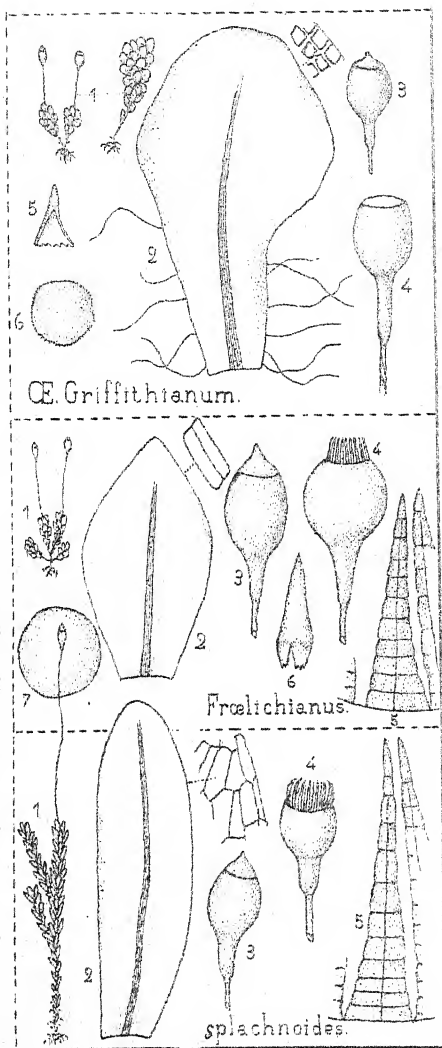


PLATE XLII.

PLATE 42. *Oedipodium Griffithianum* (from Husnot, Musc. Gall. *pl.* 54). 1, entire plants $\times 1$ and to the right enlarged; 2, leaf; 3, 4, capsules; 5, calyptra; 6, spore.

Tayloria Froelichiana (from Husnot, l. c.). 1, plants $\times 1$; 2, leaf; 3, 4, capsules; 5, portion of peristome; 6, calyptra; 7, spore.

Tayloria splachnoides (from Husnot, l. c.). 1, plant $\times 1$; 2, leaf; 3, 4, capsules; 5, portion of peristome.

Tayloria Hornschuchii (upper right, from Bry. Eur. *pl.* 281). A, plant $\times 1$; B, the same much enlarged; C, leaf apex; D, capsule; E, calyptra.

Haplodon Wormskioldii (at bottom, from Bry. Eur. *pl.* 291). A, plant $\times 1$; B, leaf apex; C, portion of peristome; D, calyptrae.

PLATE 43. *Voilia nivalis* (upper, from Bry. Eur. *pl.* 7). A, plant $\times 1$; B, leaf apex; C, basal leaf cells; D, capsule and calyptra; E, longitudinal section of capsule.

Splachnobrum Bernoullii (middle, from Pub. 267, Field Museum Nat. Hist. Botany 4: *pl.* 17. 1929. K, fruiting plant $\times 1\frac{1}{2}$; L, same $\times 9$; M, operculate capsule $\times 19$; N, stem leaf $\times 45$; O, apex of leaf $\times 300$; J, basal leaf cells next the costa $\times 300$; Q, part of cross section from upper part of leaf $\times 300$; R, same from the lower part of the leaf; S, part of peristome $\times 300$; T, median exothecial cells $\times 300$.

At bottom, 8, capsules of *Splachnum rubrum* with different magnifications (from Bry. Eur. *pl.* 295); 11, operculate capsule of *Splachnum luteum*; 14, dry and deoperculate capsule of the same (from Bry. Eur. *pl.* 296).

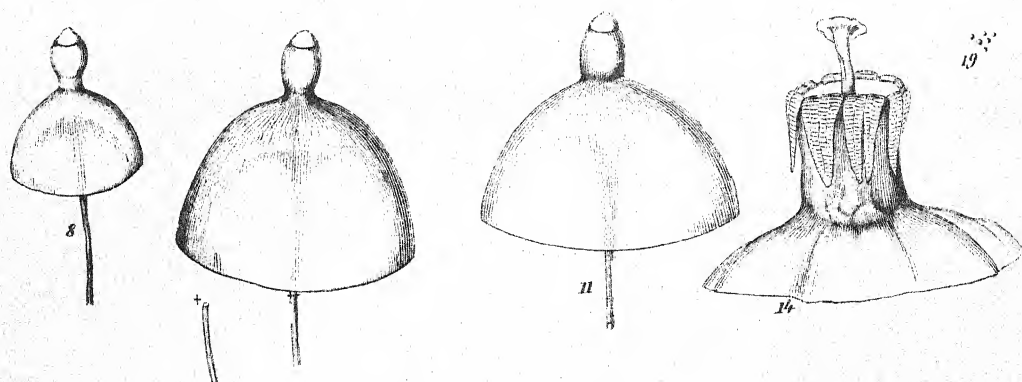
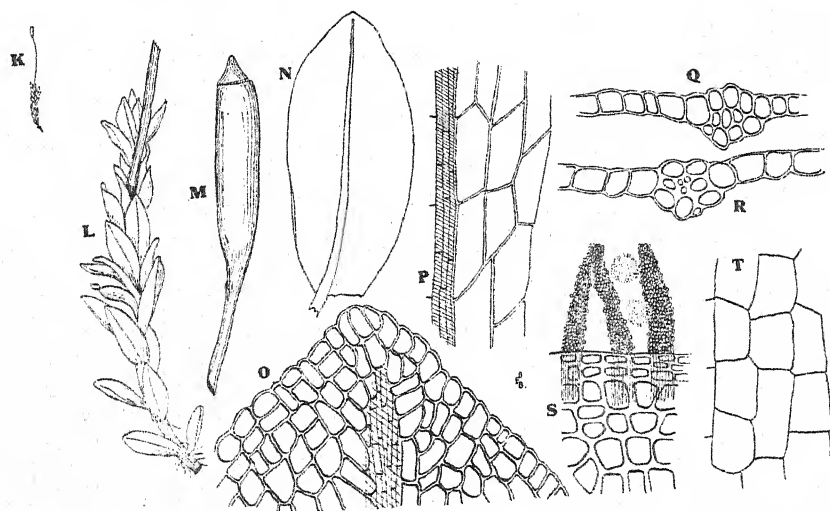
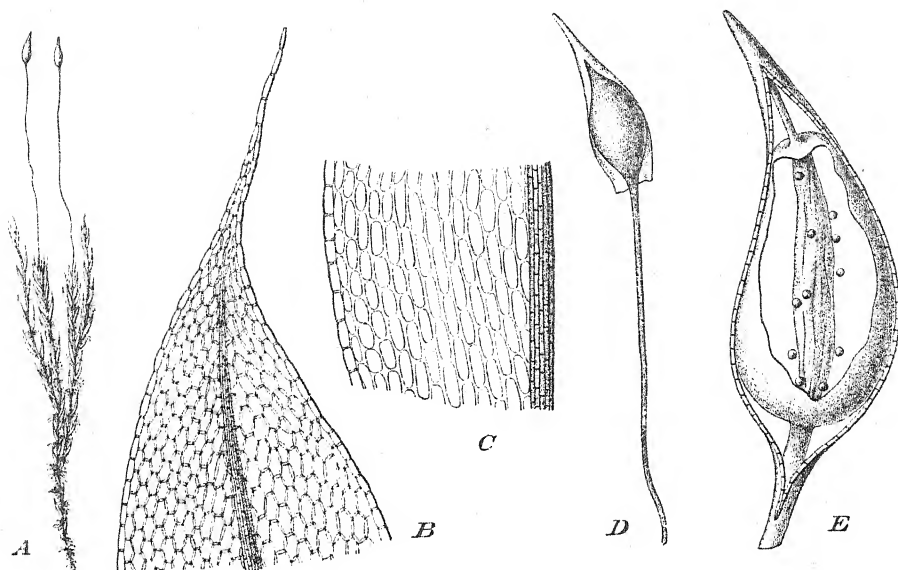


PLATE XLIII.

PLATE 44. *A. Solmsiella Kurzii*. 1, plant, ventral view, $\times 40$; 2, plant, dorsal view, $\times 40$; 3-4, ventral leaves, $\times 65$; 5-6, dorsal leaves, $\times 65$.

B. Solmsiella biseriata (from original drawings by Austin). 1, plant, ventral view, $\times 35 \pm$; 2, ventral leaf, $\times 45 \pm$; 3, dorsal leaf, $\times 45 \pm$.

C. Erpodium domingense. 1-2, ventral leaves, $\times 65$; 3-4, dorsal leaves, $\times 65$; 5, plant, dorsal view, $\times 40$; 6, ♀ branch, with sporophyte, $\times 40$.

D. Venturiella sinensis [from Engler-Prantl, (Ed. 2) 11: f. 422, by permission]. *A*, plant, $\times 1$; *B*, fertile branch, $\times 8$; *C*, stem leaf, $\times 50$; *D*, apex of leaf, $\times 175$; *E*, capsule, $\times 8$; *F*, calyptra, $\times 8$; *G*, peristome, $\times 225$.

PLATE 45. A. *Orthotrichum laevigatum Kingianum* (from Sull. Icones Musc. Suppl. pl. 55). 1, part of plant much magnified; 3, leaf; 4, cross section of leaf and leaf cells; 5, leaf cells of base and apex; 7, dry and empty capsule; 8, mouth of capsule; 9, stoma; 10, part of peristome.

B. *Orthotrichum Bolanderi* (from Sull. l. c., pl. 46). 2, portion of plant greatly magnified; 4, cross sections of leaf; 5, portion of 4 from upper leaf; 6, basal and apical leaf cells; 8, dry and empty capsule.

C. *Orthotrichum rupestre* (from Bryol. Eur. pl. 217). 1, plants natural size; 1b, portion of plant much enlarged; 2, leaves; 3, upper leaf, 3x, cross section of same; 4a and 4b, basal and apical leaf cells; 6, ripe moist capsule; 7, dry capsule; 9, portion of peristome.

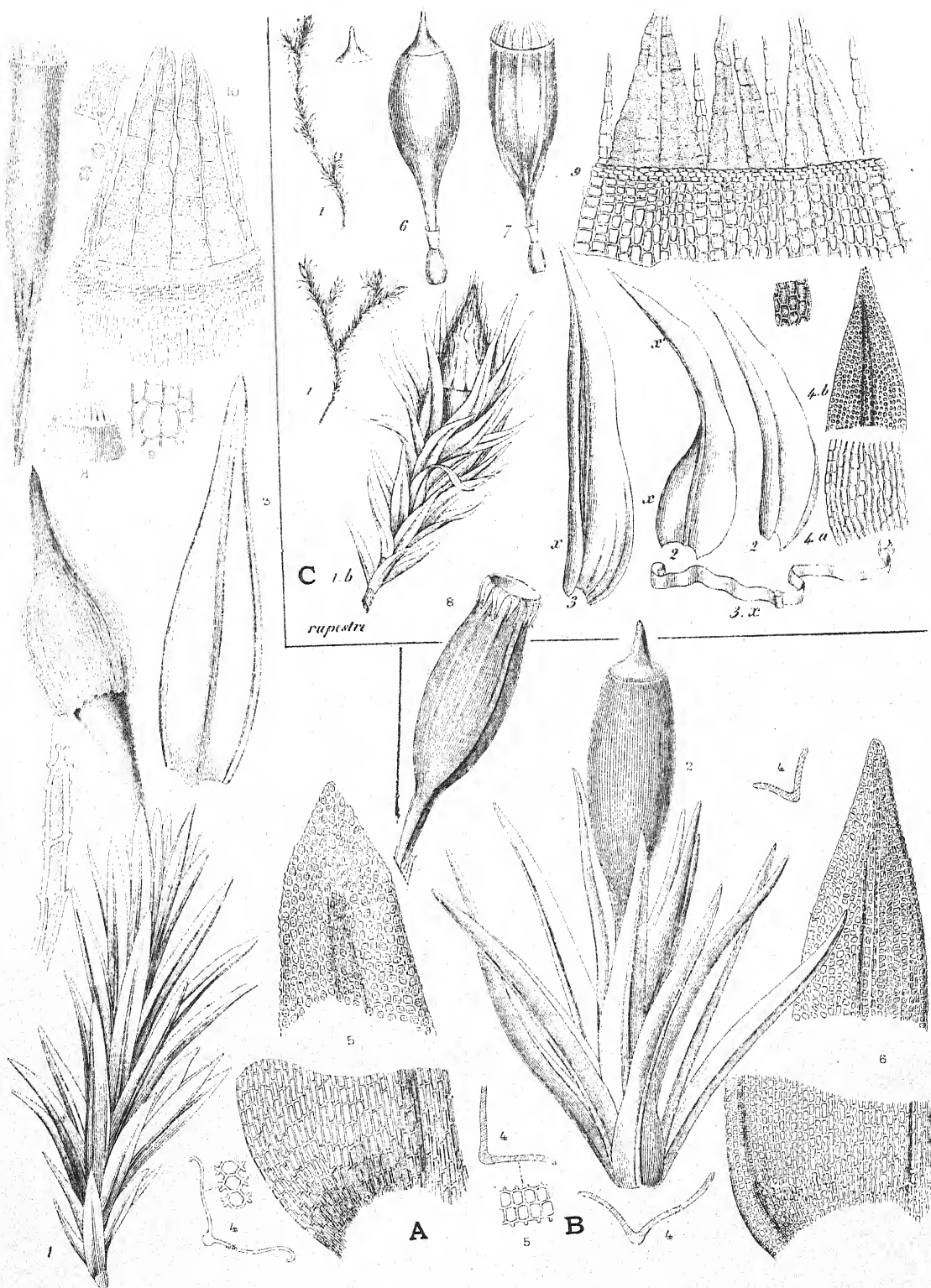


PLATE XLV.

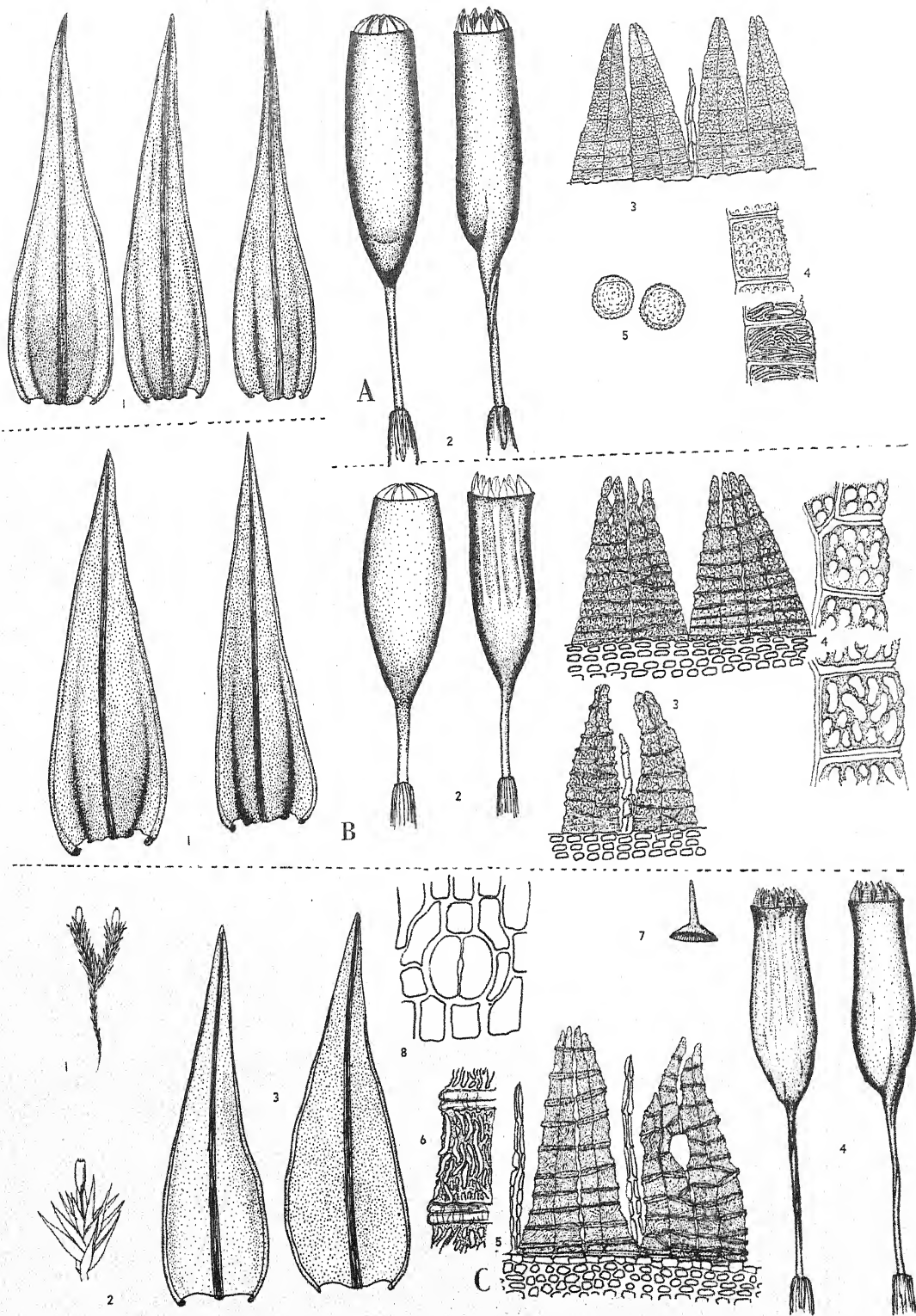


PLATE XLVI.

PLATE 46. A. *Orthotrichum Macounii*. 1, leaves $\times 20$; 2, capsules $\times 15$; 3, portion of peristome $\times 150$; 4, portions of a tooth $\times 600$; 5, spore $\times 300$.

B. *Orthotrichum texanum*. 1, leaves $\times 20$; 2, capsules $\times 15$; 3, portions of peristome $\times 150$; 4, portions of tooth $\times 600$.

C. *Orthotrichum Roellii*. 1, plant $\times 1$; 2, portion of plant $\times 3$; 3, leaves $\times 20$; 4, capsules $\times 15$; 5, portion of peristome $\times 150$; 6, portion of a tooth $\times 600$; 7, operculum $\times 15$; 8, stoma $\times 300$. (All by Flowers.)

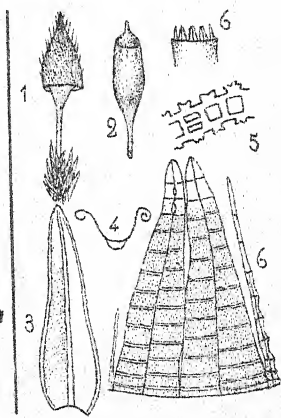
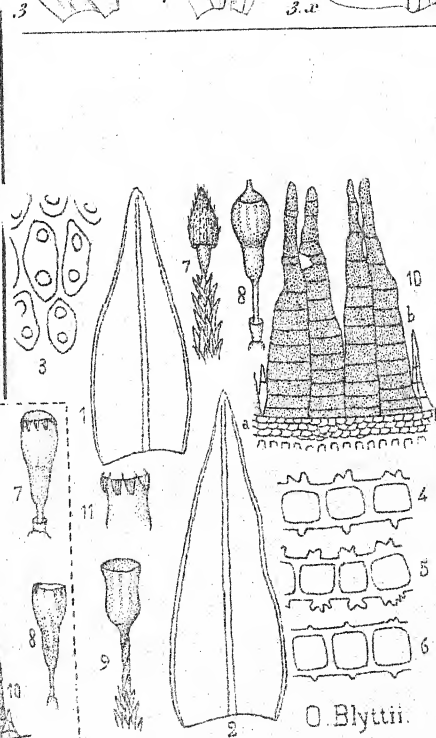
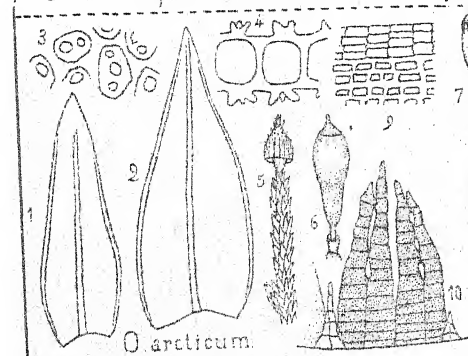
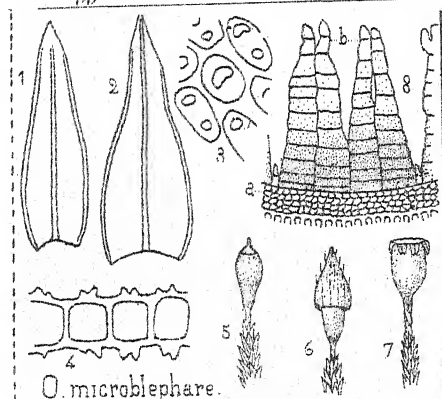
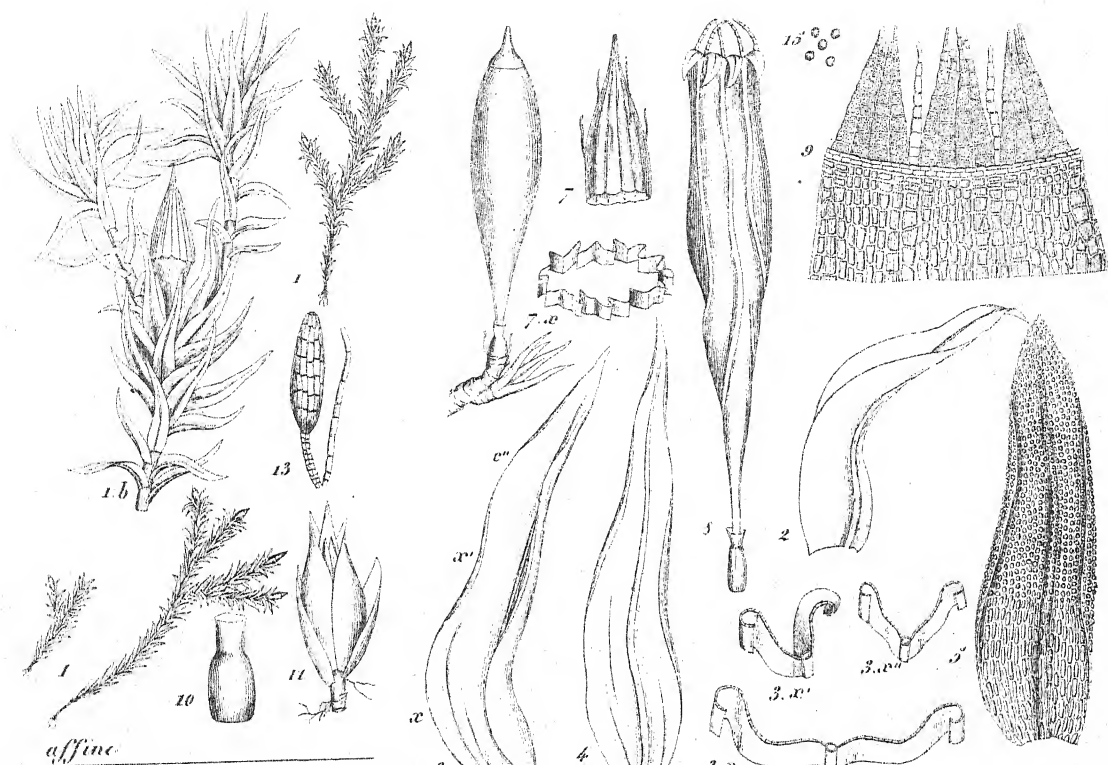
PLATE 47. *Orthotrichum laevigatum* (from Husnot, Musc. Gall. *pl.* 44). 1, upper portion of plant enlarged; 2, capsule, moist; 3, leaf; 4, cross section of same; 5, bit of cross section showing cells and papillae; 6, peristome.

Orthotrichum arcticum (from Husnot, l. c., *pl.* 47). 1 and 2, leaves; 3, leaf cells; 4, leaf cells in cross section; 5, portion of plant enlarged; 6, moist capsule; 7, 8, empty moist capsules; 9, cells at capsule mouth; 10, portion of peristome.

Orthotrichum Blyttii (from Husnot, l. c.). 1, 2, leaves; 3, leaf cells; 4, 5, 6, leaf cells in cross section; 7, portion of plant much enlarged; 8, 9, 11, capsules; 10, portion of peristome.

Orthotrichum microblepharum (from Husnot, l. c.). 1, 2, leaves; 3, leaf cells; 4, leaf cells in cross sections; 5, 6, 7, portions of plants with capsules much enlarged; 8, portion of peristome.

Orthotrichum affine (from Bryol. Eur. *pl.* 216). 1, plants about $\times 2$; 1b, portion of plant much enlarged; 2, 3, 4, 5, leaves; 3x, 3x', 3x'', cross sections of 3 as indicated; 7, moist capsule and calyptra; 7x, cross section of calyptra; 8, dry and empty capsule; 9, portion of peristome; 10, ochrea; 11, antheridial bud; 13, antheridium.



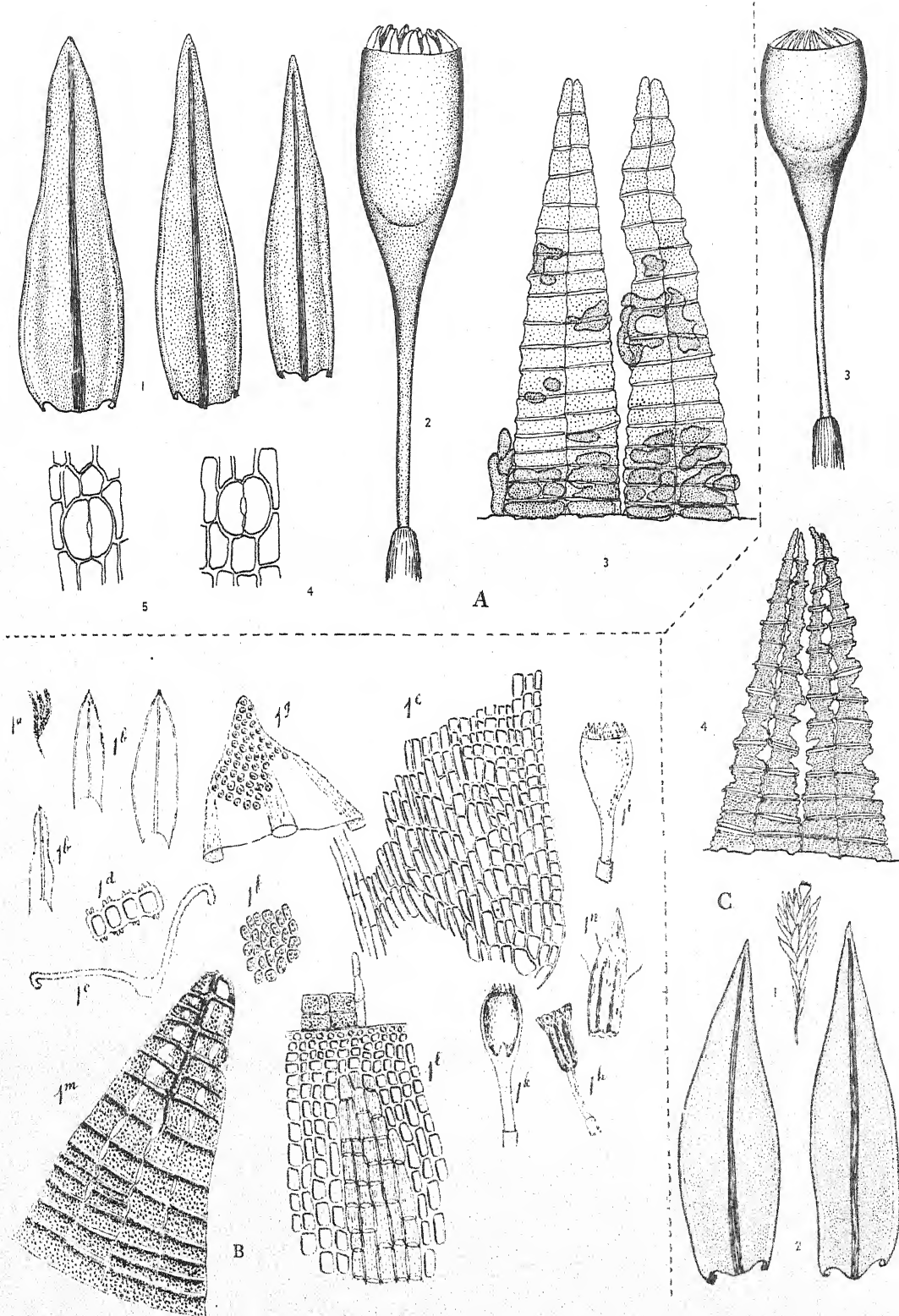


PLATE XLVIII.

PLATE 48. A. *Orthotrichum Holzingeri*. 1, leaves $\times 20$; 2, capsule $\times 15$; 3, peristome teeth $\times 150$; 4, stoma $\times 300$. (by Flowers).

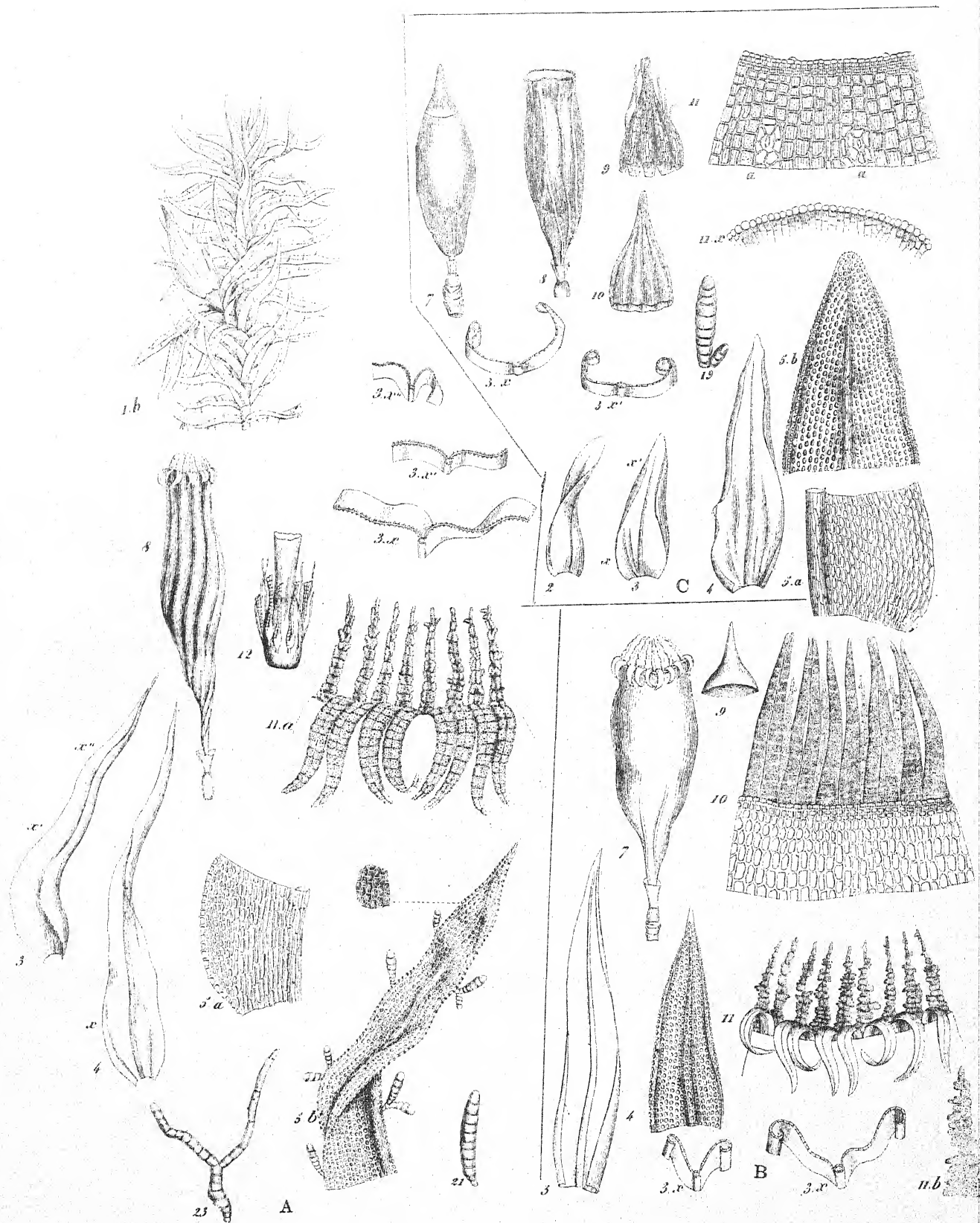
B. *Orthotrichum cancellatum* (from Univ. of Calif. Pub. 2³: pl. 27). a, entire plant $\times 1$; b, leaves $\times 13$; c, cross section of leaf $\times 60$; d, part of the same $\times 210$; e, basal portion of leaf $\times 135$; f, median leaf cells $\times 135$; g, apical cells $\times 90$; h, dry capsule $\times 13$; i, moist capsule $\times 13$; k, the same split lengthwise $\times 13$; l, portion of capsule wall and peristome $\times 90$; m, peristome tooth, ventral view $\times 112$; n, calyptra $\times 13$.

C. *Orthotrichum fenestratum*. 1, plant $\times 3$; 2, leaves $\times 20$; 3, capsule $\times 15$; 4, peristome teeth $\times 150$; 5 (under A) stoma $\times 300$ (by Flowers).

PLATE 49. A. *Orthotrichum Lyellii* (from Bryol. Eur. *pl.* 221). 1*b*, portion of plant much enlarged; 3, 4, leaves; 5*a*, 5*b*, base and apex of leaf showing cells; 3*x*, 3*x'*, 3*x''*, cross sections of leaf; 8, dry and empty capsule; 12, ochrea; 11*a*, portion of peristome; 21, 23, brood bodies.

B. *Orthotrichum striatum* (from Bryol. Eur. *pl.* 220). 3, leaf; 3*x*, cross sections of leaf; 4, apical cells of leaf; 7, dry and empty capsule; 9, operculum; 10, portion of peristome; 11, same when dry and old; 11*b*, a single segment of peristome more enlarged.

C. *Orthotrichum gymnostomum* (from Bryol. Eur. *pl.* 208). 2, 3, 4, leaves; 3*x*, 3*x'*, cross sections of 3 at points indicated; 5*a*, basal leaf cells; 5*b*, apical leaf cells; 7, moist operculate capsule; 8, dry and empty capsule; 9, 10, calyptrae; 11, exothecial cells at mouth of capsule; 11*x*, cross section of the same; 19, brood body.



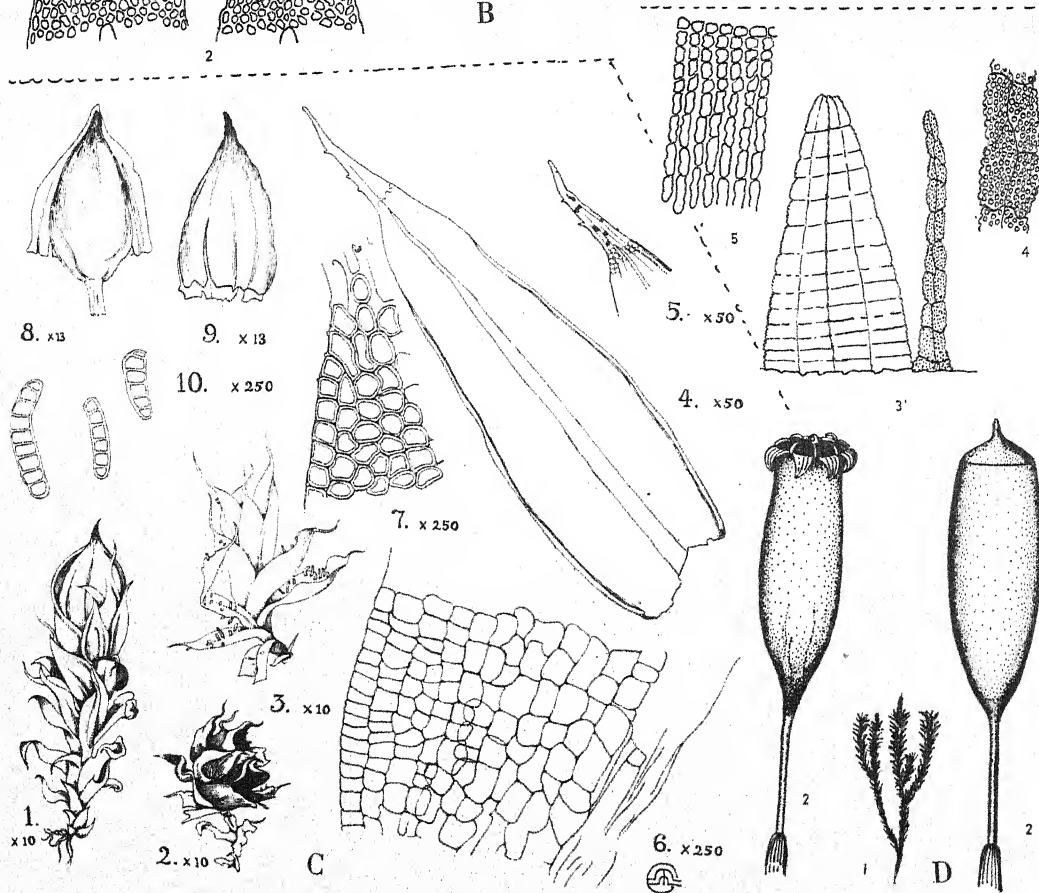
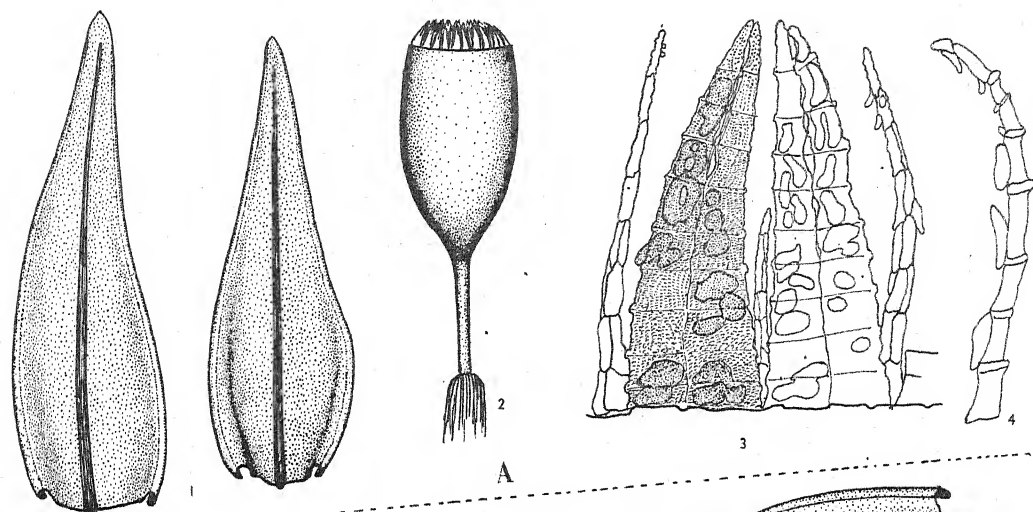


PLATE L.

PLATE 50. A. *Orthotrichum euryphyllum*. 1, leaves $\times 20$; 2, capsule $\times 15$; 3, peristome $\times 150$; 4, side view of peristome tooth showing adhering fragments of preperistome.

B. *Orthotrichum rivulare*. 1, leaf $\times 20$; 2, leaf apices $\times 300$.

C. *Orthotrichum diaphanum* from Texas, McAllister. 1, plant; 2 and 3, sterile plants, 3 bearing brood bodies; 4, leaf; 5, leaf apex; 6, basal cells; 7, apical cells; 8, capsule with calyptra; 9, calyptra; 10, brood bodies.

D. *Orthotrichum elegans*. 1, plant $\times 1$; 2, capsules $\times 20$; 3, portion of peristome $\times 150$; 4, portion of a segment $\times 600$; 5, uniform exothelial cells. (A, B and D by Flowers; C by Mrs. Cleaves.)

PLATE 51. *Orthotrichum Sprucei* (from Husnot, Musc. Gall. *pl.* 48). 1, upper portion of plant enlarged; 2, leaf; 3, leaf apex; 4, leaf cells; 5, 6, leaf cells in cross section; 7, moist capsule; 8, upper exothecial cells; 9, portion of peristome.

Orthotrichum tenellum (from Husnot, l. c., *pl.* 50). 1, leaf; 2, 3, 4, leaf apices; 5, leaf cells; 6, the same in cross section; 7, 9, upper portion of plants showing moist capsules, much enlarged; 8, same with dry and empty capsule; 10, capsule, a moist short form; 11, 12, 13, stomata; 14, cells around mouth of capsule; 15, portion of peristome; 16, 17, calyptrae.

Orthotrichum alpestre (from Husnot, l. c.). 1, leaf; 2, leaf apex; 3, leaf cells; 4, 5, 6, leaf cells in cross section; 7, upper portion of plant enlarged; 8, 9, moist capsules; 12, portion of peristome; 13, calyptra.

Orthotrichum exiguum (from Sull. Icones Musc. *pl.* 35). 2, portion of plant much enlarged; 4, 5, leaves; 8, cells of leaf apex; 9, basal leaf cells; 10, cross sections of leaf with different magnifications; 12, dry and deoperculate capsule; 13, calyptra; 14, operculum; 15, portion of peristome; 16, ochrea.

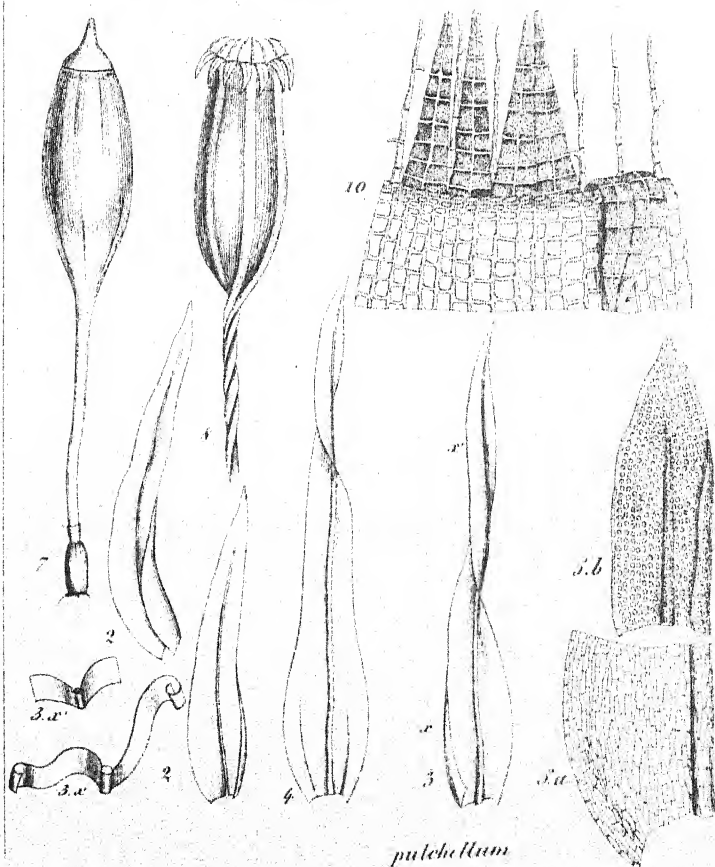
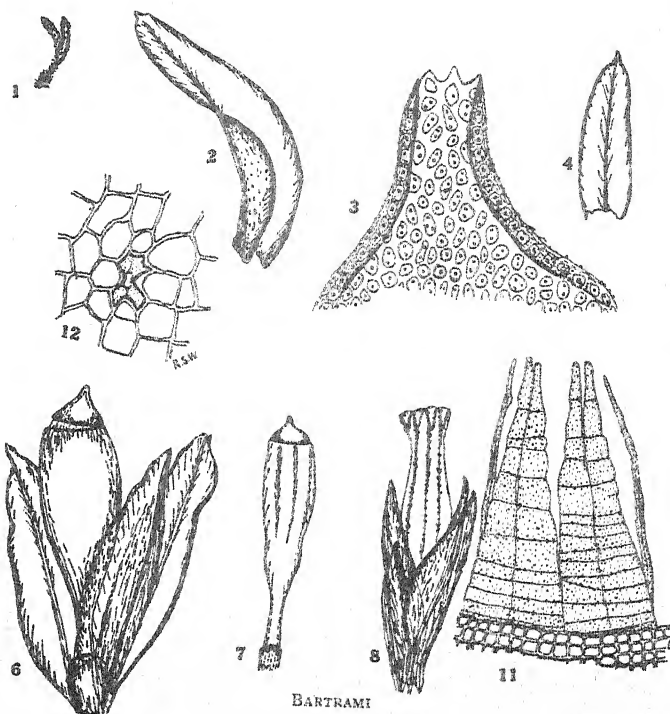
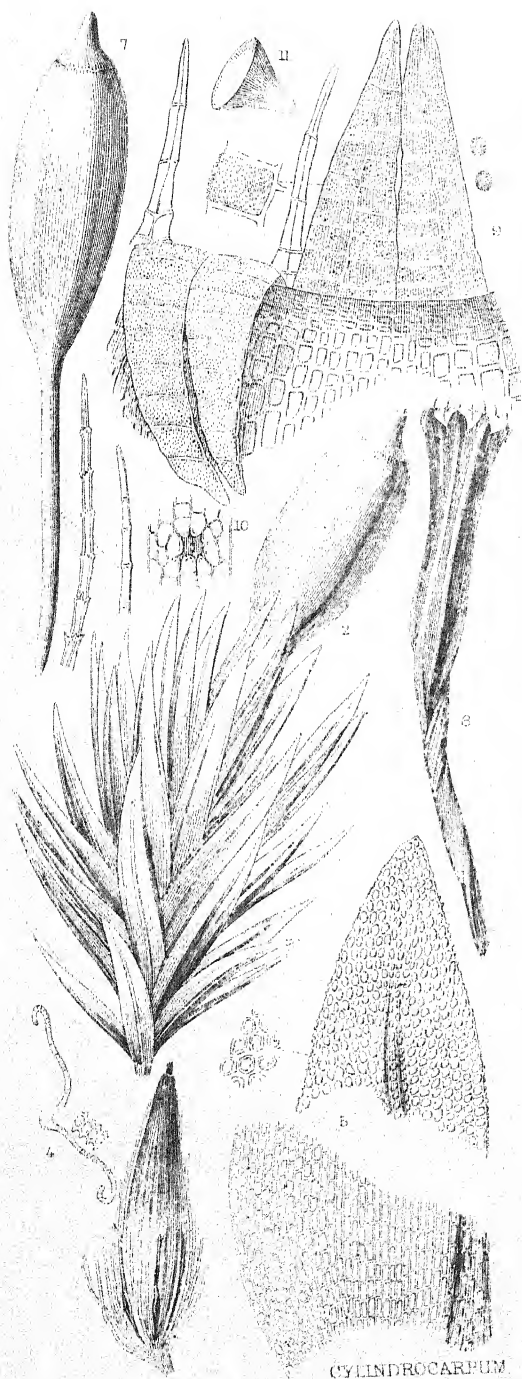


PLATE LII.

PLATE 52. *Orthotrichum cylindrocarpum* (from Sull. Icones Musc. Suppl. pl. 52). 2, upper portion of plant much enlarged; 4, cross section of leaf; 5, basal and apical leaf cells; 7, moist capsule with hairs from the calyptra beside seta; 8, dry and empty capsule; 9, portion of the peristome; 10, stoma; 11, operculum.

Orthotrichum Bartrami (from Bryol. 28: pl. 9). 1, dried plant $\times 1$; 2, upper stem leaf $\times 14$; 3, apex of same $\times 180$; 4, lower stem leaf $\times 14$; 6, moist capsule and perichaetial leaves $\times 16$; 7, dry and operculate capsule $\times 16$; 8, dry and empty capsule $\times 16$; 11, portion of peristome and annulus $\times 180$; 12, stoma $\times 180$.

Orthotrichum pulchellum (from Bryol. Eur. pl. 223). 2, 3, 4, leaves; 3x, 3x', cross sections of 3 at points indicated; 5a, 5b, basal and apical leaf cells; 7, moist operculate capsule; 8, dry and empty capsule; 10, portion of peristome.

PLATE 53. A. *Orthotrichum cupulatum*. 1, plant $\times 1$; 2, leaves $\times 20$; 3, cross section of a strongly papillose leaf $\times 150$; 4 and 5, moist capsules; 6, dry capsules $\times 20$; 7, portion of peristome $\times 150$; 8, portion of a tooth $\times 600$; 9, spore $\times 300$; 10, stoma $\times 300$.

B. *Orthotrichum strangulatum* (*O. Porteri* Aust.). 1, plant $\times 1$; 2, leaves $\times 20$; 3, cross sections of leaf $\times 150$; 4, 5, and 6, capsules $\times 20$; 7, portion of peristome $\times 150$; 8, portion of tooth $\times 600$.

C. *Orthotrichum Lescurii*. 1, leaves $\times 20$; 2, peristome teeth $\times 175$; 3, capsule $\times 20$. (All by Seville Flowers.)

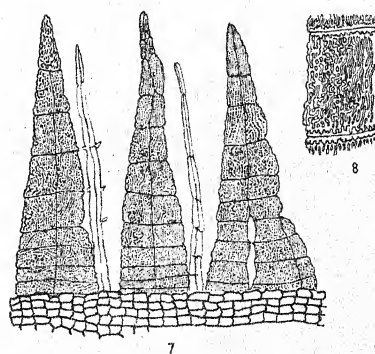
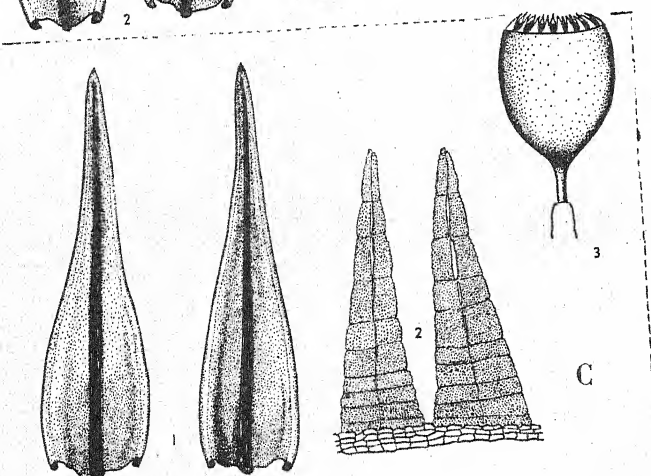
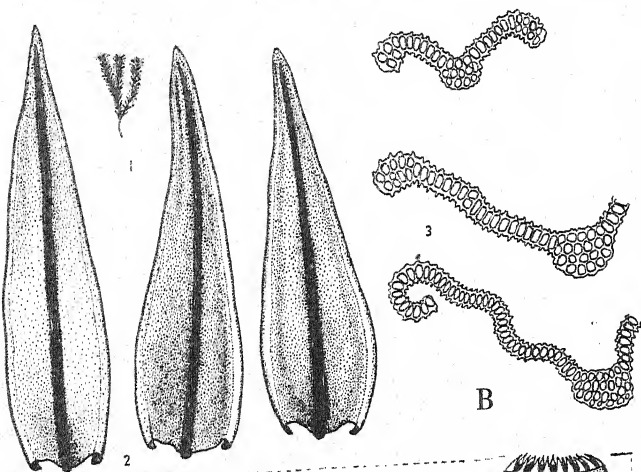
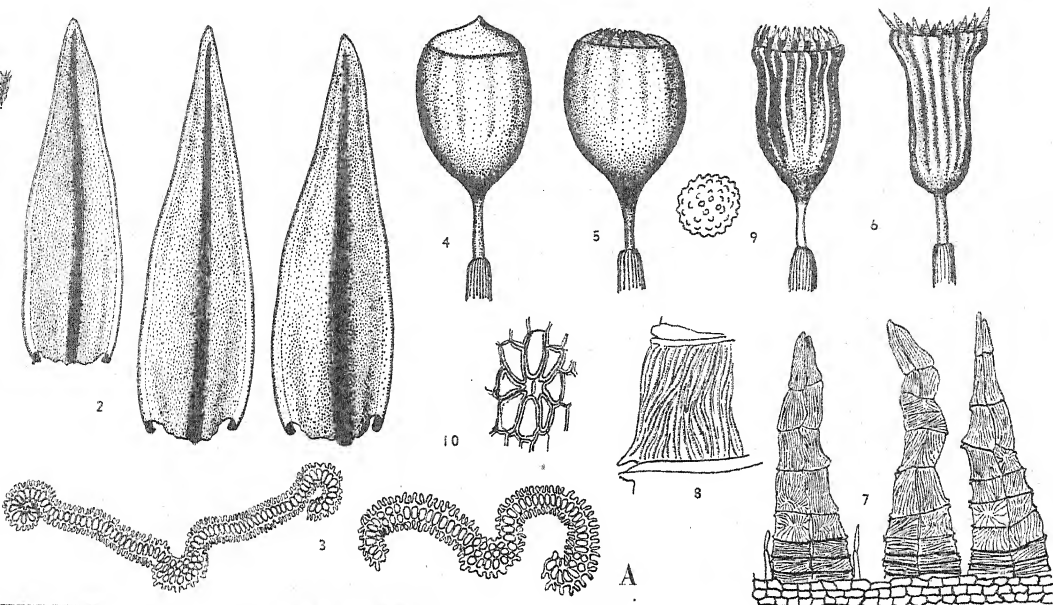


PLATE LIII.

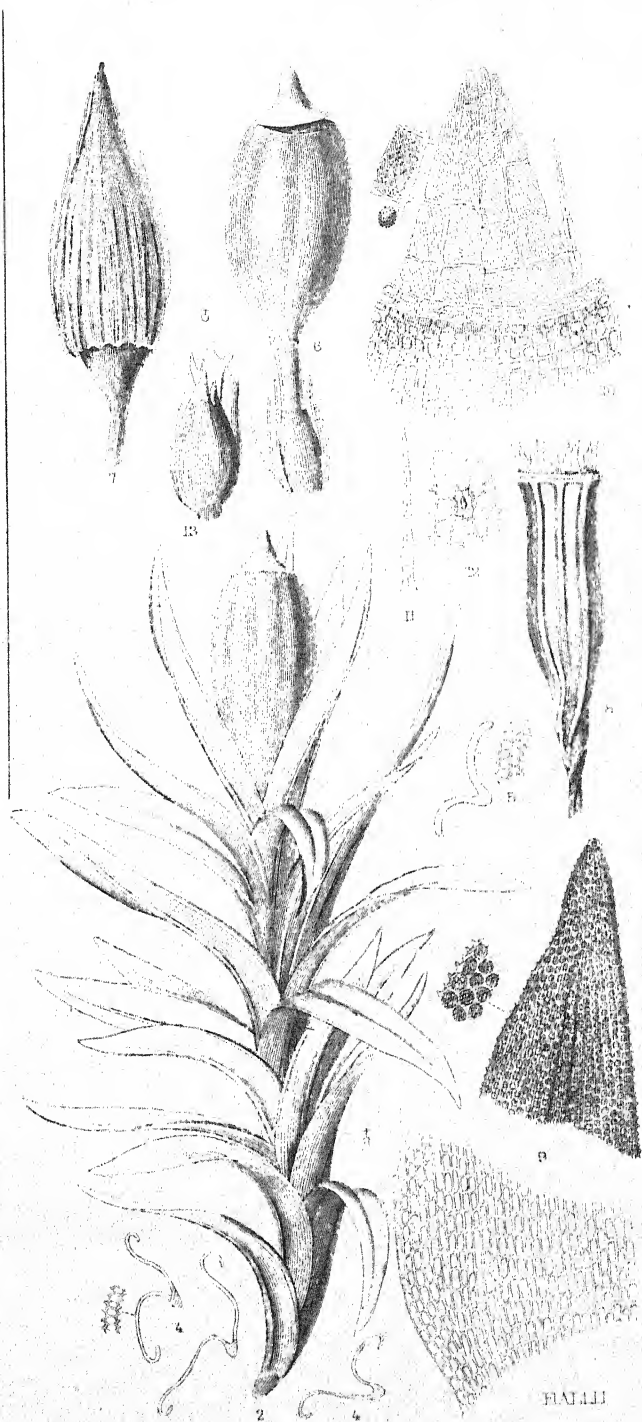
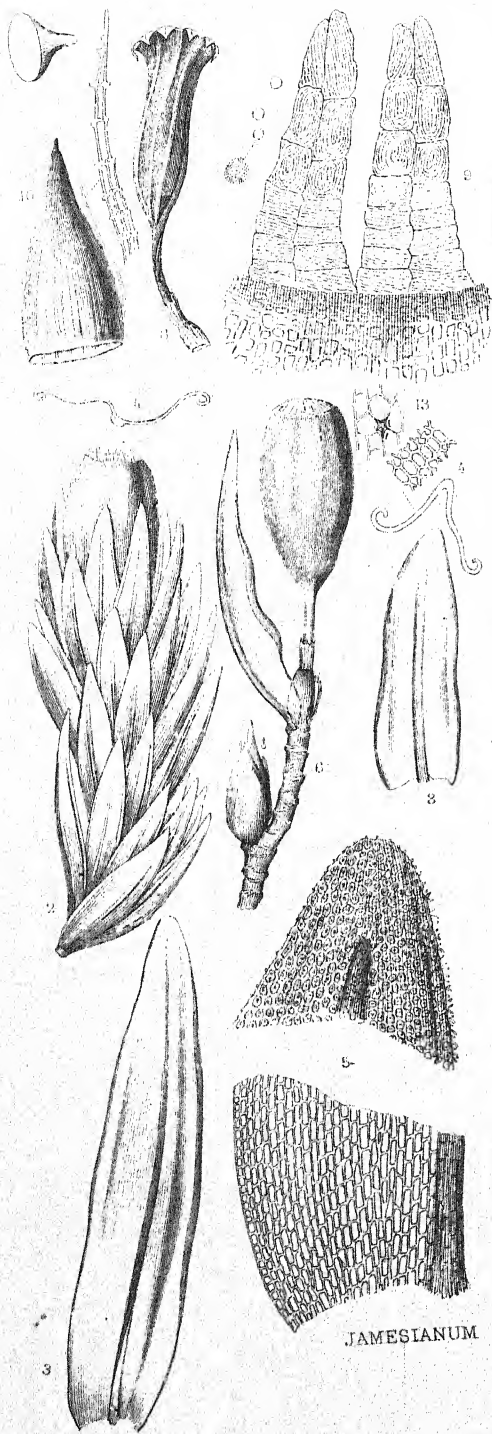


PLATE LIV.

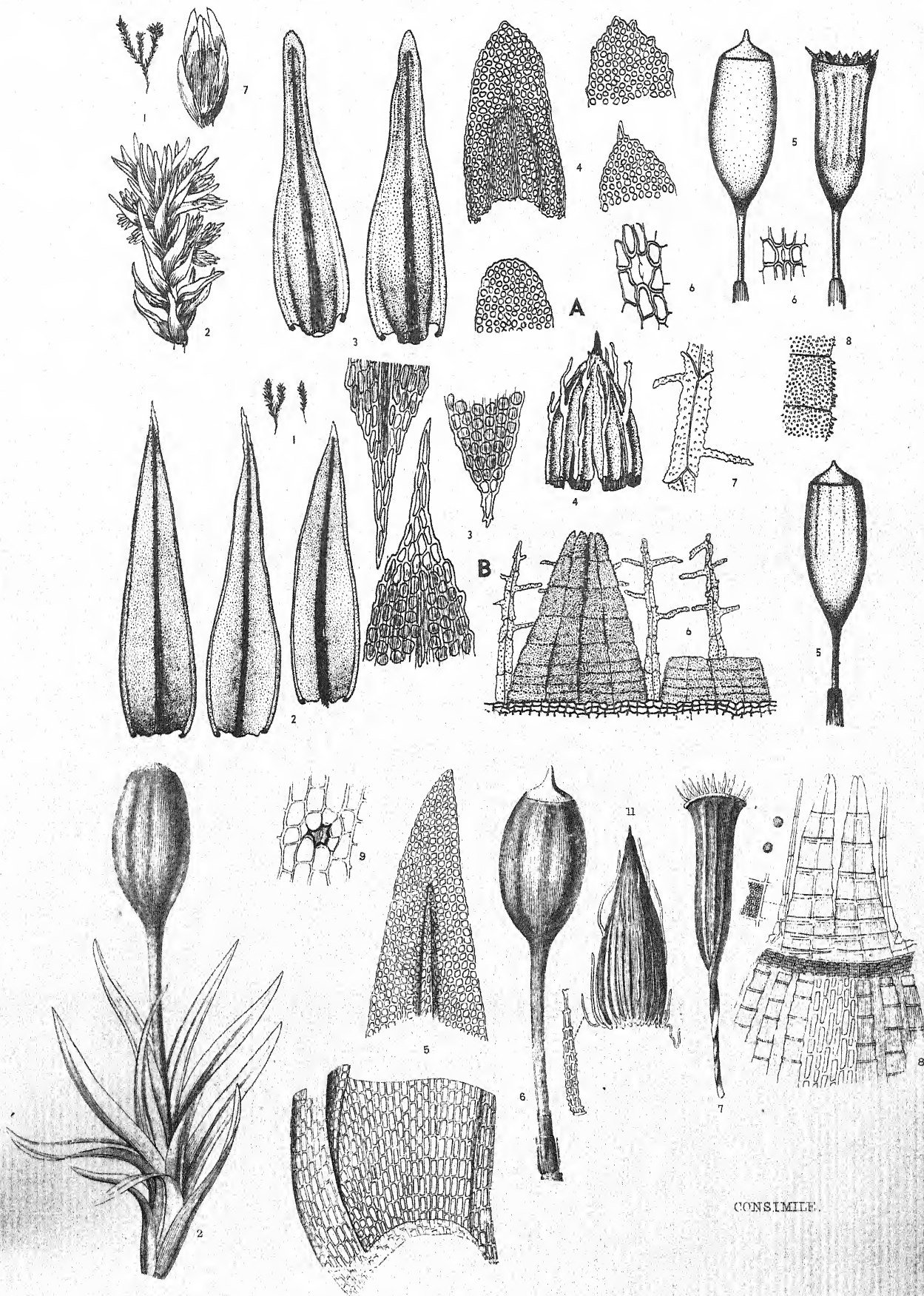
PLATE 54. *Orthotrichum Jamesianum* (from Sull. Icones Musc. Suppl. pl. 53). 2, upper portion of plant greatly magnified; 3, leaves; 4, cross sections of leaf; 5, basal and apical leaf cells; 6, portion of stem stripped of leaves, showing moist capsule and antheridial bud; 8, dry and empty capsule; 9, portion of peristome; 10, calyptra and operculum.

Orthotrichum Hallii (from Sull. l. c., pl. 45). 2, upper portion of plant greatly magnified; 4, cross sections of leaves; 5, cross section of upper part of leaf; 6, moist capsule; 7, capsule with calyptra; 8, dry and empty capsule; 9, apical and basal leaf cells; 10, portion of peristome; 11, one segment of the same; 12, stoma; 13, antheridial bud.

PLATE 55. A. *Orthotrichum pallens parvulum*. 1, portion of plant $\times 1$; 2, portion of plant $\times 8$ showing antheridial branches; 3, leaves $\times 20$, 4, apices of leaves $\times 300$; 5, capsules $\times 20$; 6, stomata $\times 300$.

B. *Orthotrichum Garretthii*. 1, plants $\times 1$; 2, leaves $\times 20$; 3, leaf apices $\times 150$; 4, calyptra $\times 20$; 5, capsule $\times 20$; 6, portion of peristome $\times 150$; 7, portion of segment $\times 600$; 8, portion of tooth $\times 600$. (A and B by Seville Flowers).

Orthotrichum conismile (from Sull. Icones Musc. Suppl. pl. 43). 2, upper portion of plant greatly magnified; 5, apical and basal leaf cells; 6, moist operculate capsule; 7, dry and empty capsule; 8, portion of peristome; 9, stoma; 11, calyptra.



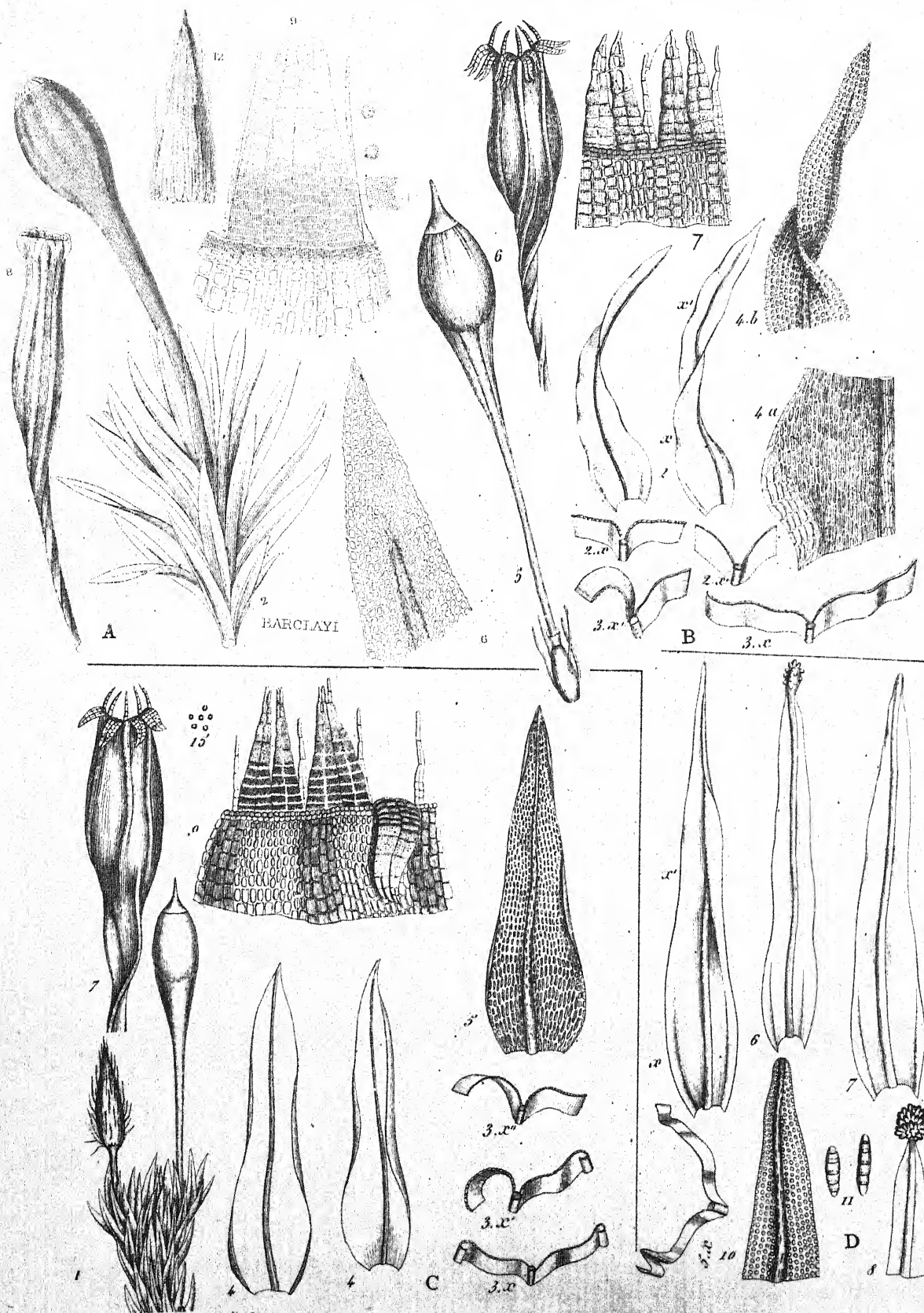


PLATE LVI.

PLATE 56. A. *Ulota Barclayi* (from Sull. Icones Musc. Suppl. pl. 56). 2, part of plant with capsule greatly enlarged; 6, apical leaf cells; 8, dry and empty capsule; 9, portion of peristome; 12, calyptra.

B. *Ulota curvifolia* (from Bryol. Eur. pl. 226). 2, leaves; 2x, 2x', 3x, 3x', cross sections of leaves; 4a and 4b, basal and apical leaf cells; 5, moist operculate capsule; 6, dry and empty capsule; 7, portion of peristome.

C. *Ulota americana* (from Bryol. Eur. pl. 226). 1, portion of plant much enlarged; 4, leaves; 3x, 3x', 3x'', cross sections of leaf; 5, leaf, showing areolation; 7, dry and empty capsule; 9, portion of peristome; 15, spores.

D. *Ulota phyllantha* (from Bryol. Eur. pl. 223). 6, 7, leaves; 8, leaf apex with brood bodies; 3x, cross section of leaf near base; 10, apex of leaf showing areolation; 11, brood bodies.

PLATE 57. A. *Ulota Funstoni*. 1, leaves $\times 20$; 2, perichaetial leaf $\times 20$; 3, capsule $\times 10$; 4, two peristome teeth $\times 150$; 5, portion of tooth $\times 600$; 6, leaf apex $\times 40$; 7, areolation of acute and obtuse leaf apices $\times 150$.

B. *Ulota obtusiuscula*. 1, leaf apices $\times 150$; 2, portion of peristome $\times 150$; 3, portion of tooth $\times 600$.

C. *Ulota megalospora*. 1, plant $\times 3$; 2, leaves $\times 20$; 3, cross sections of leaf; 4, leaf apices; 5, deoperculate capsule; 6, part of peristome $\times 150$; 7, part of tooth $\times 600$. (Drawings by Seville Flowers.)

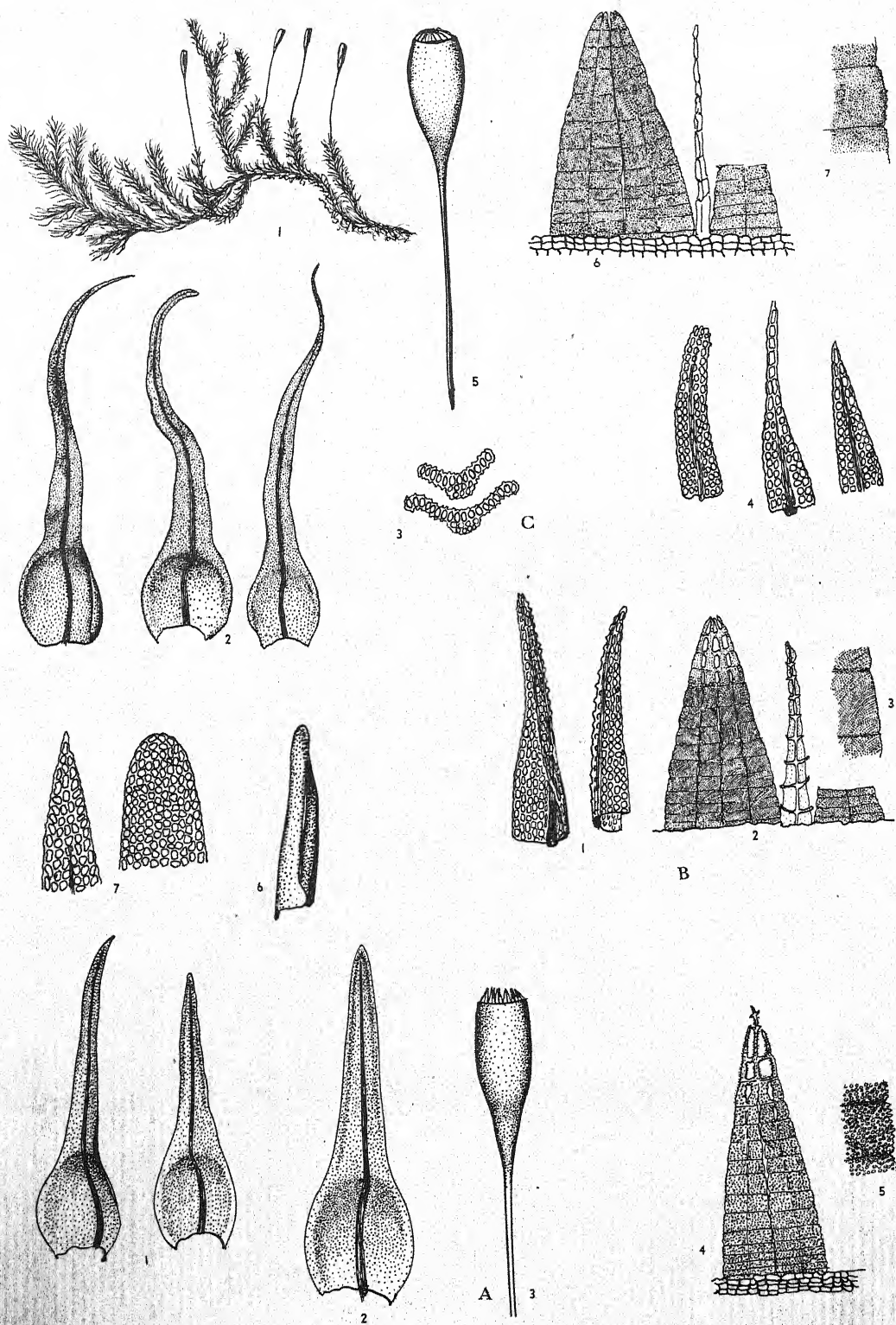


PLATE LVII.